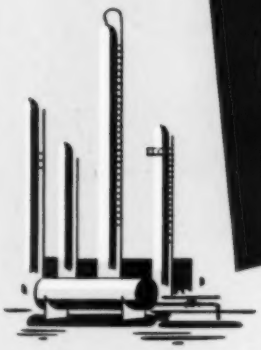
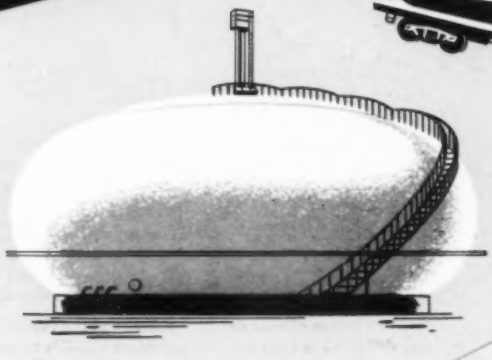
PETROLEUM
REFINER
OCTOBER, 1952
SPECIALIZED FOR REFINING, NATURAL GASOLINE, AND PETRO-CHEMICAL ENGINEERING, OPERATION AND MANAGEMENT

Service

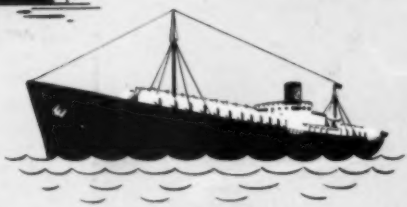




NATURAL GASOLINE
PROPANE
ISO-BUTANE
BUTANE
ISO-PENTANE

NORMAL PENTANE
HEXANE
HEPTANE
HEAVY NAPHTHA
STA-VOL-ENE

30 Service YEARS



WARREN
PETROLEUM CORPORATION
TULSA, OKLAHOMA — CABLE ADDRESSES: Stavalene, Western
EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN, TEXAS CITY AND WAREHOUSE, HOUSTON, TEXAS

8-hour job now takes 4 hours

At a western magnesium reduction plant something besides magnesium has just been reduced. The steam at the end of the 1½ mile long steam line wasn't so hot—and neither was the production record of the plant at that location.

Then 26 old-type steam traps were replaced with Yarway Impulse Traps. Now there is only a 18° temperature drop from the boilers to the end of the line. *Most important, the plant 1½ miles from the boilers is now able to do work in 4 hours that previously took 8 hours.*

That's trap efficiency! It's evidence of the fact that Yarways are designed to send the most premium B.T.U.'s at top temperatures into your process or product. *They get equipment hotter, sooner . . . and keep it hot.*

Other Yarway features—small size, one moving part, easy installation, low maintenance, low cost, stainless steel construction. Nearly 750,000 Yarways have already been installed. For your Yarways, see a nearby industrial distributor . . . 216 stock and sell Yarways.

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FREE TRAP SELECTOR

It's important to have the right trap in the right place. New 20-page selector tells quickly and easily which *is* the right Yarway trap for any application. Write for your free copy.

YARWAY

the steam trap

designed with more production in mind

PETROLEUM REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

Volume 31, No. 10 — October, 1952

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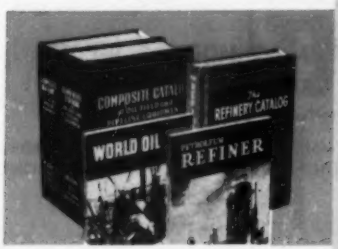

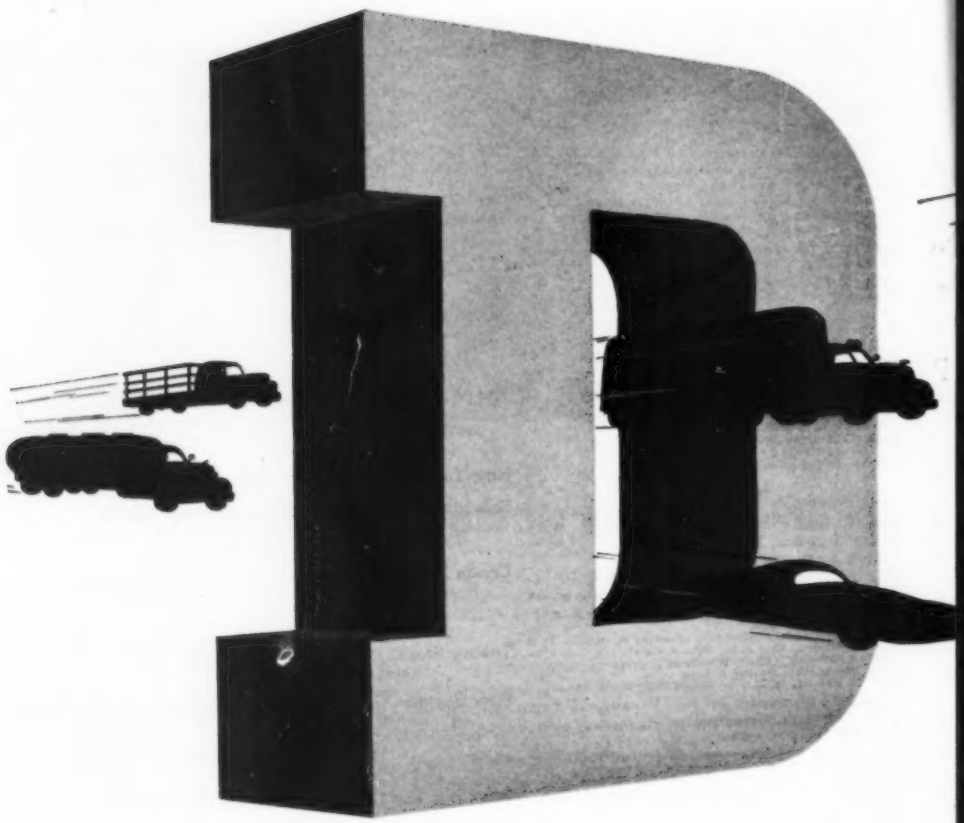

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The operating efficiency of synthetic fluid-type cracking catalysts is important. This operating efficiency can be assured by uniformity of physical characteristics and chemical purity. Davison's production of microspheroidal (M-S*) is tops in uniformity . . . providing all users with a highly efficient synthetic fluid-type cracking catalyst. Your requirements can also be supplied in ground (DA-1*) form. Write for further descriptive information. Experienced Davison Field Service Engineers backed up with complete laboratory testing facilities are part of Davison's service.

*T.M.T.D.C.C.

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Baltimore 3, Maryland

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NO NEED TO BORE OUT BAR STOCK!

TIMKEN® heavy-wall pressure tubing is answer to today's higher operating pressures

IF rising pressures in your chemical plant, steam power plant or petroleum refinery call for heavier-walled tubing, you can save money by getting it ready-made from the Timken Company. No need to bore out bar stock. The Timken Company can supply heavy-wall tubing thick enough to withstand today's extreme pressures. Typical examples are shown in photo at right. Sizes available up to 10½" O.D.

Timken Company metallurgists are the recognized authorities on heavy-wall pressure tubing. They'll help you select the best size and analysis to meet your particular requirements. They have 24 different analyses to choose from, backed by over 20 years of research and experience in high pressure and high temperature steels.

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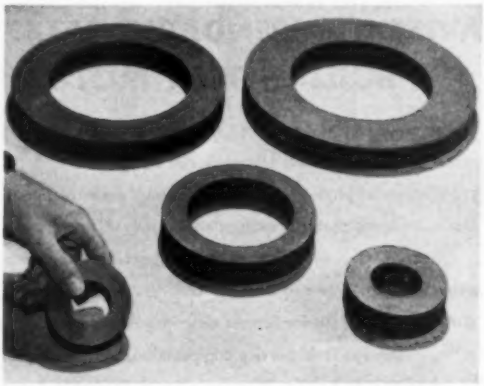


YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

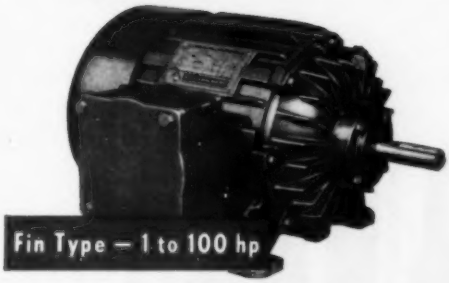
KEEP MOTOR COSTS DOWN

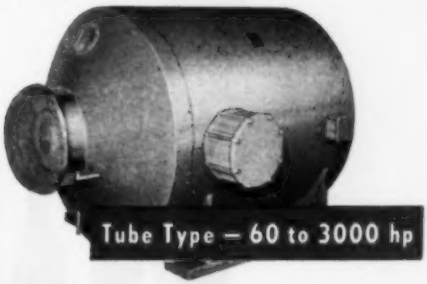
Everywhere IN YOUR REFINERY

1 to 3000 hp FOR EVERY REFINERY NEED

. . . practically self-cleaning

. . . built for outdoor installation





MAINTENANCE COSTS go way down when you use Allis-Chalmers fin-type explosion-proof motors. The entire heat radiating surface is exposed. There are no enclosed air passages to collect dirt and moisture . . . to clog and cause overheating. If cleaning should be required, it can be done quickly and easily with a cloth, air hose or vacuum cleaner.

Bearings in Allis-Chalmers Type APZZ explosion-proof motors are lubricated at the factory and should need no attention for years. However, if relubrication is desirable, it can be done without removing the motor from service. In addition to close fitting seals at the outer ends of the shaft, the bearings are protected from dust and dirt by a large reservoir of grease on the outer side of the bearing.

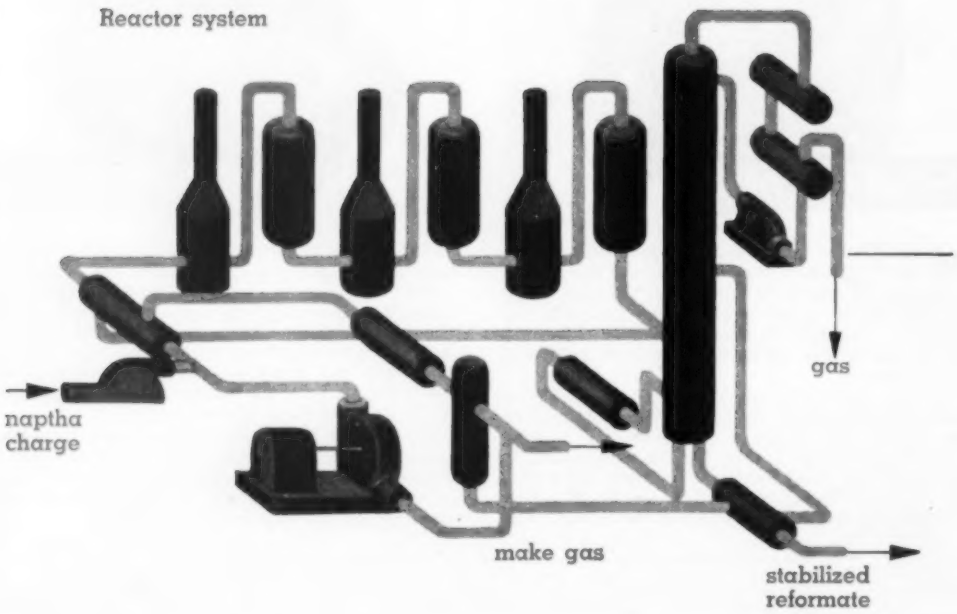
THE COOLING SYSTEM on Allis-Chalmers tube-type explosion-proof motors is practically self-cleaning. The system consists of a group of longitudinal tubes surrounding the stator. Warm internal air circulates around them while cool outside air is blown through them. Since the tubes are straight and smooth, the cooling air keeps them clean. If dirt should stick, it can easily be removed with a long-handled brush. Tubes may be made of a variety of materials as required by atmospheric conditions.

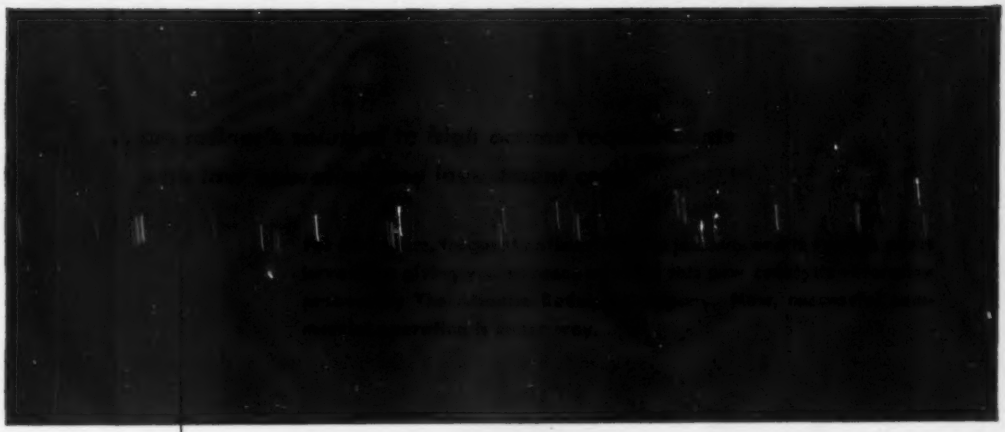
Bearings in Allis-Chalmers tube-type motors may be either grease lubricated, ball type, or sleeve bearings, depending on the size and speed of the motor. Both types have highly effective seals against dirt and dust, which makes this motor especially well suited for outdoor installation. A-3865

YOU CAN GET COMPLETE DETAILS on all Allis-Chalmers explosion-proof motors from 1 to 3000 hp with Underwriter's Labels up to 800 hp at 3600 rpm from Bulletins 51B7149 and 51B7286. To get your copies, call your nearby Allis-Chalmers Authorized Distributor or District Office or write Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

the Atlantic catalytic reforming process





it's the catalyst that counts

Since catalytic reforming was first utilized, numerous processes have been introduced to increase its benefits. None of these completely satisfied our requirements. So we looked for the answer in the catalyst itself.

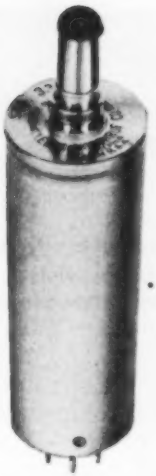
years of research

Years of continuous laboratory study were devoted to the problem . . . in a search for a new catalyst with superior qualities. This extensive research paid off in a completely new catalyst which is the heart of the Atlantic Catalytic Reforming Process. This catalyst combines improved selectivity, greater stability, excellent resistance to poisoning, and ease of regeneration.

now in commercial operation

This process is now in commercial operation. It is giving the results expected. Our engineers are ready to give you the whole story. Call or write The Atlantic Refining Company, Research and Development Dept., P. O. Box 8138, Philadelphia 1, Pa. (Telephone, Howard 5-2345.)

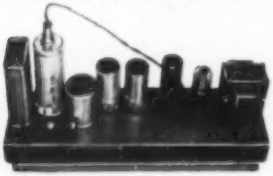
ATLANTIC



A lot of engineering for a Component!

and every Speedomax user benefits by it!

Converter's job in Speedomax instruments is to receive the (often very small) direct current signal which is related to the temperature, stress pH or other condition being measured, and produce an alternating voltage. This output is amplified, and then directs the balancing system to measure, record, and if desired control.



Good engineering shows in this Amplifier's thorough filtering, high impedance, and plug-in connection to the rest of the Speedomax.

Good engineering shows in this Slidewire's non-inductive winding and in absence of any flexible leads which might form inductive loops.

Good engineering shows in this balancing motor's small size, and in its torque ample to operate accessory control and signalling fitments.

● The operating precision of the thousands of Speedomax Recorders and Controllers which serve industry and science begins with the engineering of components like this Converter. Our specifications apply at all stages—all the way back to the plants which make metals, insulation materials, etc., for us. These specs represent also the best thinking of our suppliers' engineers. The resulting materials are thus quality-controlled for us—and us alone.

From these materials our engineers tell our factory how to make converter parts to truly tight specifications. Some parts require principally flatness, or elasticity, or dimensional stability. Reeds need correct natural frequency. Many parts of course combine various needs; each gets its requirements.

Life tests show Fidelity and Stamina. Ingenious and often original design creates from these parts a converter with noise level equivalent to only 0.2 microvolt in an emf potentiometer circuit. And this fidelity promotes accurate measurement and control.

Running on life tests since 1948, present-model converters are today still well inside performance tolerances. Such a run equals 21.9 years of 8-hours-a-day, 200-days-a-year-service—or 1.9 years more than the present age of the first Speedomax.

This kind of engineered performance is also built into the amplifier, slidewire, motor and scores of other exclusively Speedomax parts. It's at your service whether you want to control a tower, plot an X-Y function, or record vital facts about atoms or molecules. Call on L&N application engineers in selecting the exact range (from among thousands) and the exact measuring circuit (from among 2300) to meet your needs. Write our nearest office, or 4923 Stenton Avenue, Philadelphia 44, Pa.

CAREER OPPORTUNITIES AT L&N

Expansion program of this long-established firm has many features to attract outstanding recent graduates in engineering and science. Opportunities are in sales field engineering, product and application engineering, research, advertising, market development. Widely-respected policies assure recognition of progress and achievement. Address Personnel Manager for preliminary interview at nearest of 17 L&N offices.

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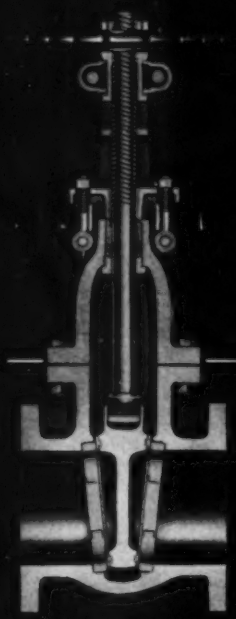
Instruments • automatic controls • furnaces

JJ AJ ND46(6b)



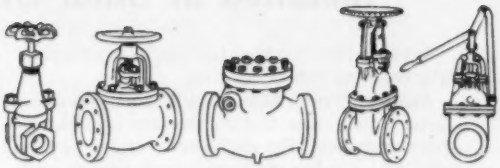
IRON

COMPLETE LINES OF IRON VALVES AND PIPE FITTINGS are manufactured by Walworth in a variety of types, pressure ratings, sizes, and patterns for general industrial use.

Walworth also manufactures complete lines of valves (including Lubricated Plug Valves), and pipe fittings made of steel, bronze, and special alloys.

These valves and pipe fittings, plus Walworth-made pipe wrenches total approximately 50,000 items and are sold through distributors in principal centers throughout the world.

Walworth engineers will be glad to help you with your problems. For further information call your local distributor, nearest Walworth sales office, or write to Walworth Company, General Offices, 60 East 42nd Street, New York 17, New York.



Iron valves in gate, globe, angle, check, and lubricated plug types are manufactured by Walworth. Illustrated is a sectional view of a Walworth No. 726F Standard Iron Body, Bronze Mounted, Wedge Gate Valve with flanged ends. This line of valves is available in sizes 2 to 30 inches. Similar valves of All-Iron type are also available.

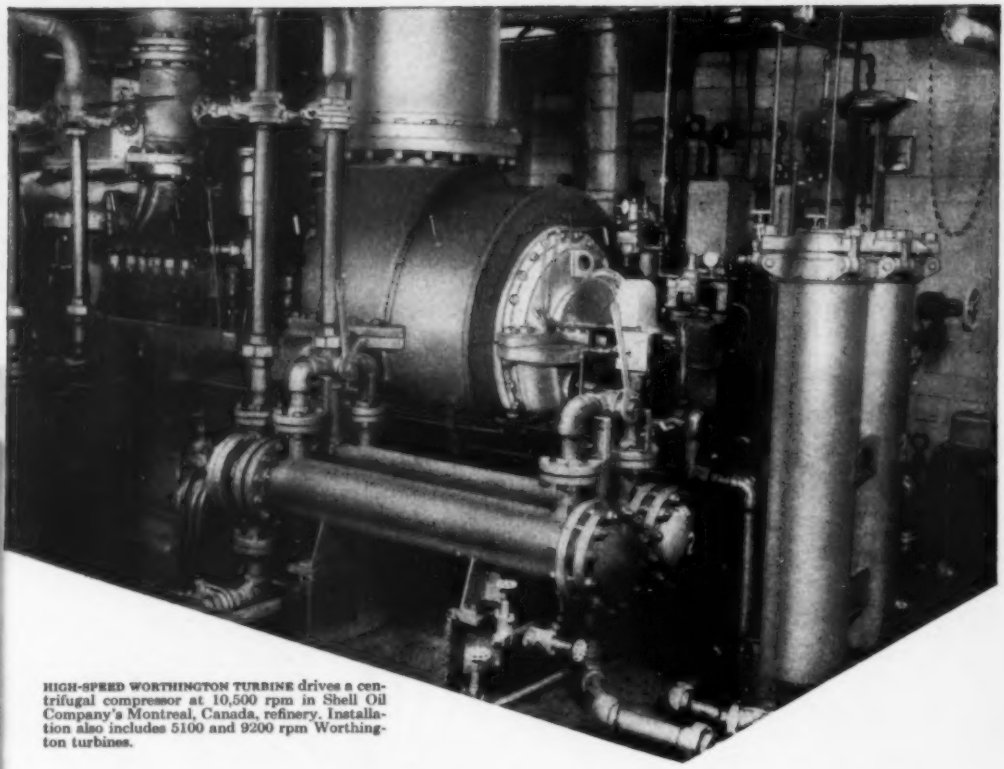
WALWORTH

Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



HIGH-SPEED WORTHINGTON TURBINE drives a centrifugal compressor at 10,500 rpm in Shell Oil Company's Montreal, Canada, refinery. Installation also includes 5100 and 9200 rpm Worthington turbines.

10,500-rpm turbine is third Worthington Compressor Drive Turbine installed at Shell Oil's Montreal refinery

It was in 1950 that Shell Oil built its new big catalytic cracking unit in Montreal.

And it was three high-speed Worthington steam turbines they chose to drive the very vital blowers and compressors. The 10,500-rpm turbine, like the other two, is so free of vibration that after two years of operation its speed can barely be detected on a vibrating-reed tachometer.

Cat-cracker service requires continuous 24-hour-a-day operation so that reliability is of prime importance. Such operation is typical with Worthington centrifugal compressor and blower drive turbines. But it's not the only reason they're preferred in hundreds of plants outside as well as inside the U. S. A.

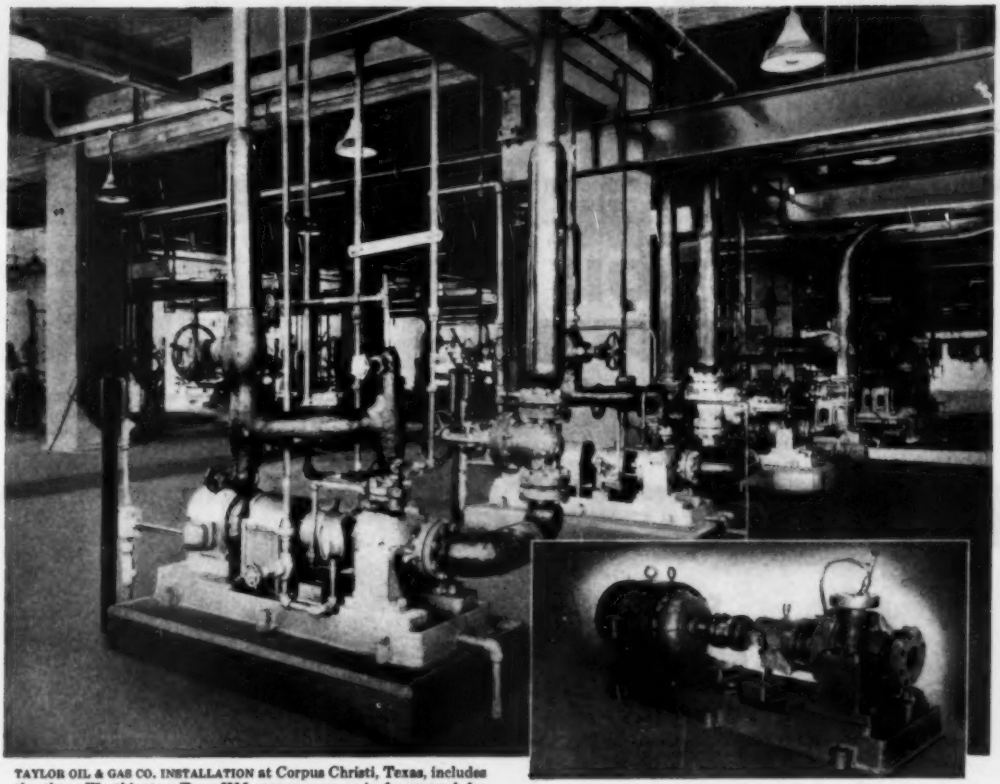
With a high-speed Worthington steam turbine you can forget costly speed-increasing gears. You easily set the exact speed needed with various types of control and governing arrangements designed specifically for your requirements. Steam consumption is at a minimum, maintenance requirements are simple.

Write for Bulletin 1966 entitled "High Speed Turbines for Your Centrifugal and Blower Drives." Worthington Corporation, Steam Turbine Division, Wellsville, New York. T.2.10

A GREAT TEAM IN STEAM

WORTHINGTON

Steam Turbines



TAYLOR OIL & GAS CO. INSTALLATION at Corpus Christi, Texas, includes the three Worthington Type-HM process pumps in foreground for pumping gasoline at 310 F. Pumps in background are Worthington Type HR's.

WORTHINGTON TYPE-HM CENTRIFUGAL PUMP—a really versatile process pump—is available with conventional stuffing box or mechanical seal, in cast iron, bronze, carbon steel, stainless steel and Worthite.

This Heavy-Duty Process Pump answers Dozens of Pumping Problems

This is a heavy-duty process pump that will handle hydro-carbons such as propane, butane, naptha, gasoline and oil . . . chemicals such as SO_2, caustics, freon and anhydrous ammonia . . . and can be used for boiler feed and heater drain service as well.

It's designed for continuous service and will withstand hot or cold liquids . . . suction pressures to 300 lbs . . . and corrosive or non-corrosive liquids. It's *water-jacketed* but built so that it *can be installed without water cooling* where pumping temperatures permit.

Learn more about this Worthington Type-HM Process Pump and what it can do in your refinery pumping applications.

Write for Bulletin W-341-B14 to Worthington Corporation, Centrifugal Pump Division, Harrison, New Jersey.

C.2.10

Types HR and HB. Twenty sizes. Capacities up to 1,800 gpm. Developed heads up to 900 ft. Proper selection of material permits use for temperatures far below zero to 600 F, for pressures from high vacuum to 750 psig.

Type HD. Hydraulically-balanced double-suction impeller handles boiling liquids with low submergence. Capacities range from 600 to 3,200 gpm at heads up to 700 ft. To 850 F and 550 psig.

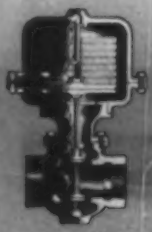
Type CNE. For loading or transfer service. Capacities to 1,500 gpm. Heads to 300 ft.

Type HM. Available in 12 sizes. Capacities to 700 gpm. Heads to 475 ft. Up to 800 F.

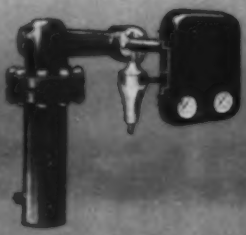
WORTHINGTON

Centrifugal Pumps

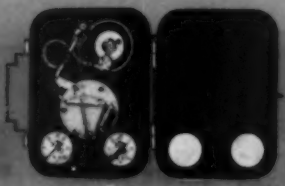
The World's Broadest Line Assures You the Right Pump for Every Job



BACK PRESSURE REGULATOR
TYPE 196



LIQUID LEVEL CONTROLLER
TYPE 808



PRESSURE CONTROLLER
PILOT TYPE 1400

TIME CYCLE CONTROLLER
TYPE 995

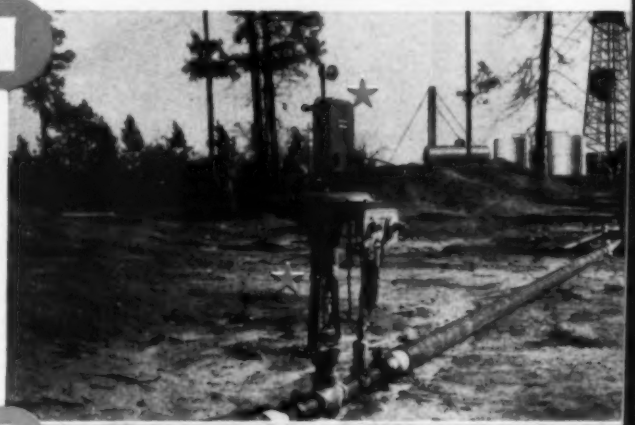
IN THE OIL & GAS INDUSTRIES CLIMAX

Place an orange star on every Climax Control and Regulator used in the oil and gas business and you'd give the entire industry the appearance of a constellation on earth. Climax Controls are so numerous . . . their applications so varied you'll find them wherever there is the smell of gas or crude; wherever men behind closed gates process and refine to get the many products that spring from oil and gas.

DRILLING 1

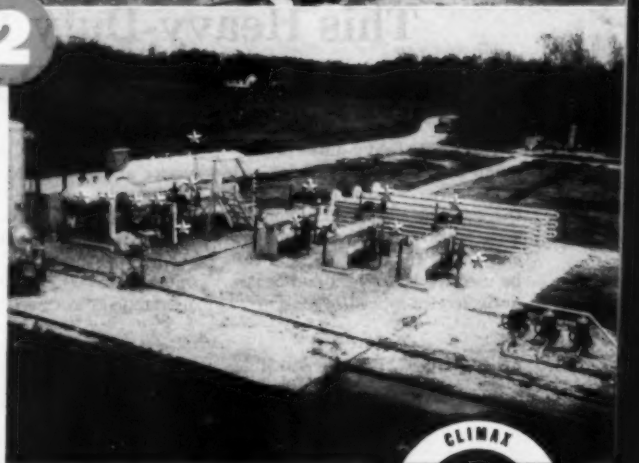
Even here ...at the very beginning...

you'll find Climax represented. At the drilling rig you're quite likely to see Climax Diaphragm Control Valves and Climax Fuel Supply Regulators. And as you progress still further into the various steps of the oil and gas industry you find Climax playing many vital roles.



PRODUCTION 2

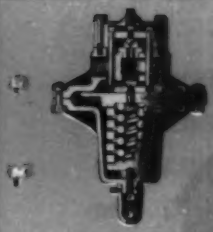
Operators lean heavily on Climax here. Around the wellhead there are Climax Controllers—Safety Shut-Off Regulators . . . Pressure Reducing and Back Pressure Regulators . . . Time Cycle Controllers for gas lift wells. For field gathering systems there are Climax Liquid Level Controllers, 3-way Valves, Pressure Controllers and Diaphragm Motor Valves used on dehydrators and desulfurizers. Climax Pressure Controllers are used on separators, low temperature separation units, BS&B Glycol Injection Systems (pictured here), emulsion treaters, free water knockouts, BS&B Stabilizers, indirect heaters and for automatic tank battery controls.



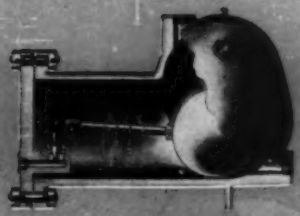
The Story of Climax Controls is a book in itself.

We would like you to have this book for ready reference. Several sections have been recently revised to cover new and improved Climax Controls. So that your business can keep up with consumption demands BS&B keeps Climax Controls ahead of the trend, to give you the very best and latest control and regulator equipment. Let us send you this book . . . It's FREE. Or, ask your BS&B Man. There are 76 Climax Control Centers to help you.

CLIMAX
BS&B
CONTROLS
OUR 50TH YEAR

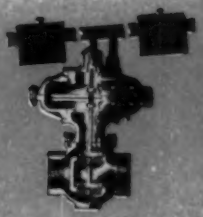


PRESSURE REDUCING REG.
TYPE 260



DUO-PHASE CONTINUOUS DRAINER
TYPE 90

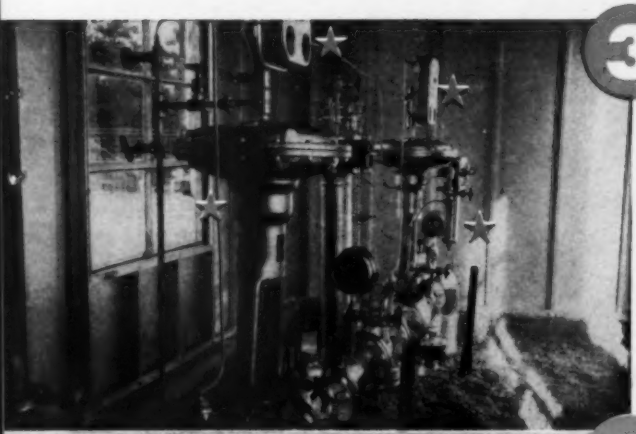
DIAPHRAGM CONTROL VALVE
TYPE 86



VACUUM REGULATOR
TYPE 8

CONTROLS★ serve right down the line

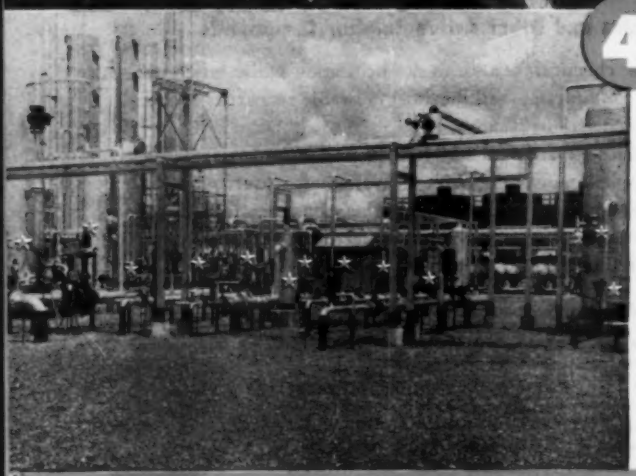
...from drilling rig through refining



3 GAS PIPE LINES

and Compressor Stations

The mission of Climax Controls carries right on through. Around gas pipelines and compressor stations the Climax name appears on many pressure controllers, diaphragm motor valves, drainers and traps. All along oil pipelines are Climax automatic controls for pump operation.



4 REFINING

Gasoline Plants and Petro-Chemical Plants

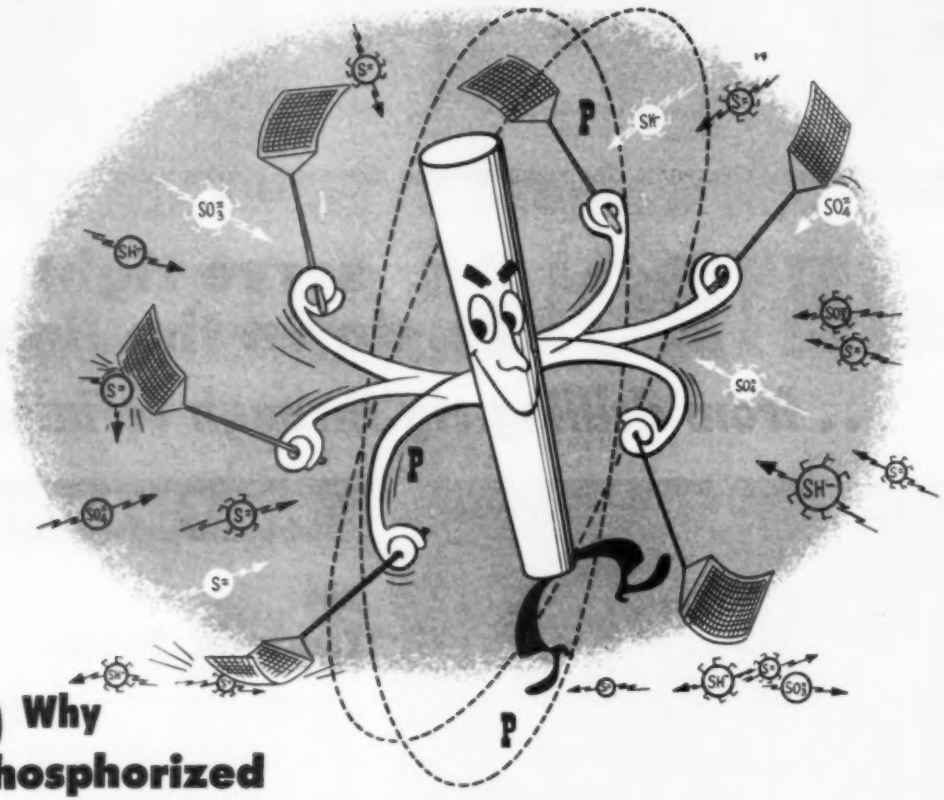
In this final stage of a major industry Climax Controls are very much in evidence. Throughout these orderly and concentrated jungles of piping, heat exchangers, vessels and ladders Climax does almost every conceivable regulating job, with Liquid Level Controllers, Pressure Controllers, Diaphragm Control Valves, Pressure Regulators and Relays.

BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division Dept. 4-F10

7500 East 12th Street

Kansas City 3, Missouri



Why Phosphorized Admiralty Heat Exchanger Tubes?

High Resistance to Sulfides and Other Active Sulphur Compounds

In order to assure *uniform* chemical composition and inherent *soundness*, Scovill produces Phosphorized Admiralty tubes by its continuous billet-casting process which consistently maintains the optimum amount of phosphorus. Adding as little as 0.02% phosphorus to Admiralty also gives maximum resistance to dezincification while retaining all the other desirable properties of this alloy.

Scovill's 40-page Condenser Tube Booklet is available to users who request it on their business letterhead. Scovill Manufacturing Company, 14 Mill Street, Waterbury 20, Connecticut.

Only Scovill Phosphorized Admiralty Has All These Advantages . . .

- Uniformity and soundness resulting from Scovill continuous-casting techniques
- Relative immunity to dezincification
- High resistance to sulfides and other active sulphur compounds
- Satisfactory resistance to weak mineral acids and acid mine waters
- Good resistance to velocities under 7 fps
- Excellent performance at relatively high operating temperatures
- Superior performance in fresh, salt or brackish waters

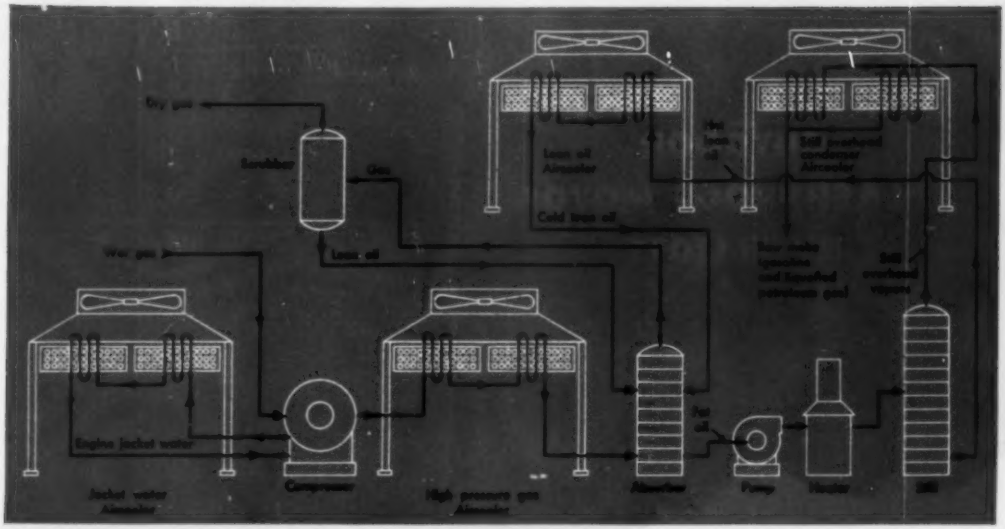
SCOVILL HEAT EXCHANGER TUBES

"You can't buy better brass"

SCOVILL

A PRODUCT OF SCOVILL

- cooling engine jacket water
- cooling high pressure gas
- condensing overhead vapors
- cooling lean oil



versatile ALCO AIRCOOLERS handle all these cooling duties at natural gasoline plants

ALCO Aircoolers demonstrate their versatility in natural gasoline plants. The simplified flow diagram above shows how Aircoolers are used to cool jacket water, cool high pressure gas, condense overhead vapors and cool lean oil.

The flexibility of ALCO fabricated steel header design also permits handling a number of different fluid streams in one tube bundle. For example, in some installations a single Aircooler may perform both the lean oil cooling and overhead vapor cooling functions.

ALCO Aircoolers are the logical and economical solution to all types of cooling problems where abundant good water is not available. Scale and corrosion troubles are eliminated.

For details call your nearest ALCO Sales Engineer at Beaumont, Chicago, Dunkirk, Houston, Los Angeles, New York or Tulsa.

Send Coupon for ALCO Aircooler Bulletin.

ALCO

ALCO PRODUCTS DIVISION
AMERICAN LOCOMOTIVE COMPANY
Plants: Dunkirk, N. Y. • Beaumont, Texas

***In step with tomorrow*— ALCO Aircoolers, Heat Exchangers, Evaporators, Feedwater Heaters, Pressure Vessels, Pipe**

D

ALCO PRODUCTS DIVISION
AMERICAN LOCOMOTIVE COMPANY
Schenectady, N. Y.

Gentlemen:
Please send me the ALCO Aircooler Bulletin.

Name ..... Position .....

Company .....

Address .....

City ..... Zone ..... State .....

Teamed for tops

OUTDOOR SPLASHPROOF MOTOR BY ELLIOTT

Elliott outdoor motor in operation under spray test at factory.

ON THE DRIVING END, the motor that is rapidly becoming famous throughout industry for its ability to operate anywhere in the open, absolutely unprotected, quite unaffected by any climatic condition, snow, rain, sleet, fog, dust storm, heat or cold.

With the cost of housing eliminated, and location limitations thrown overboard, these big Elliott motors have turned a new page in industrial plant design and costs. Available from first size above NEMA frames and larger. Call or write your nearest Elliott District Office for consultation.

For Elliott Crocker-Wheeler industrial motors, 1-200 hp, write Elliott Company, Jeannette, Pa.

ELLIOTT

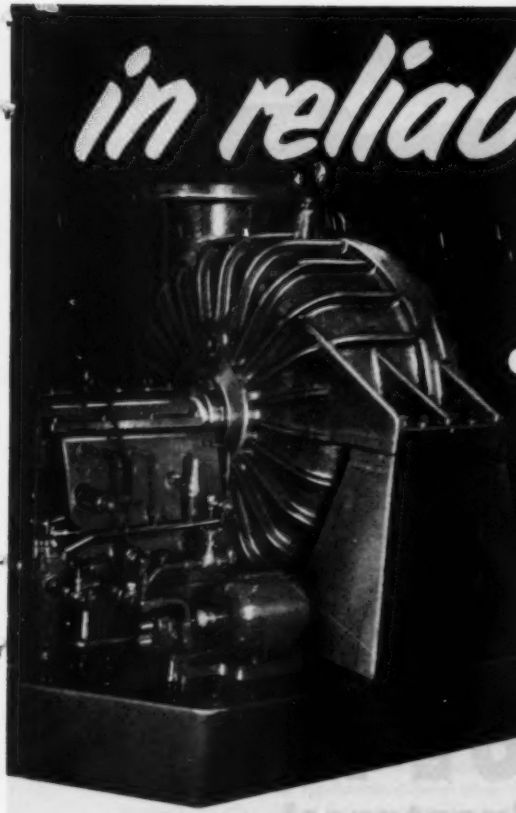
Ridgway Division • Ridgway, Pa.

PLANTS ALSO AT: AMPERE, N. J. • SPRINGFIELD, O. • NEWARK, N. J.

C2-4

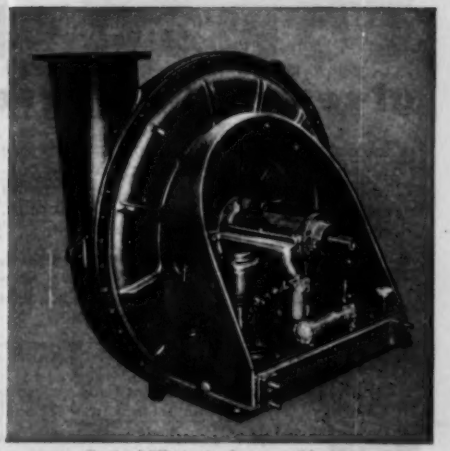
in reliability!

HIGH PRESSURE CENTRIFUGAL BLOWER BY ELLIOTT



AT THE DRIVEN END, one of the high-pressure gas circulators that Elliott builds, for operation in a closed system, suitable for discharge pressures up to 1000 psig or more.

Elliott centrifugal blowers are custom-built to the requirements of the installation. They are characterized by unusually rugged construction throughout and several large multi-stage units have recently made some outstanding authenticated records for continuous operation and low maintenance. Built for motor drive, motor geared drive or turbine drive. Call or write your nearest Elliott District Office for consultation.

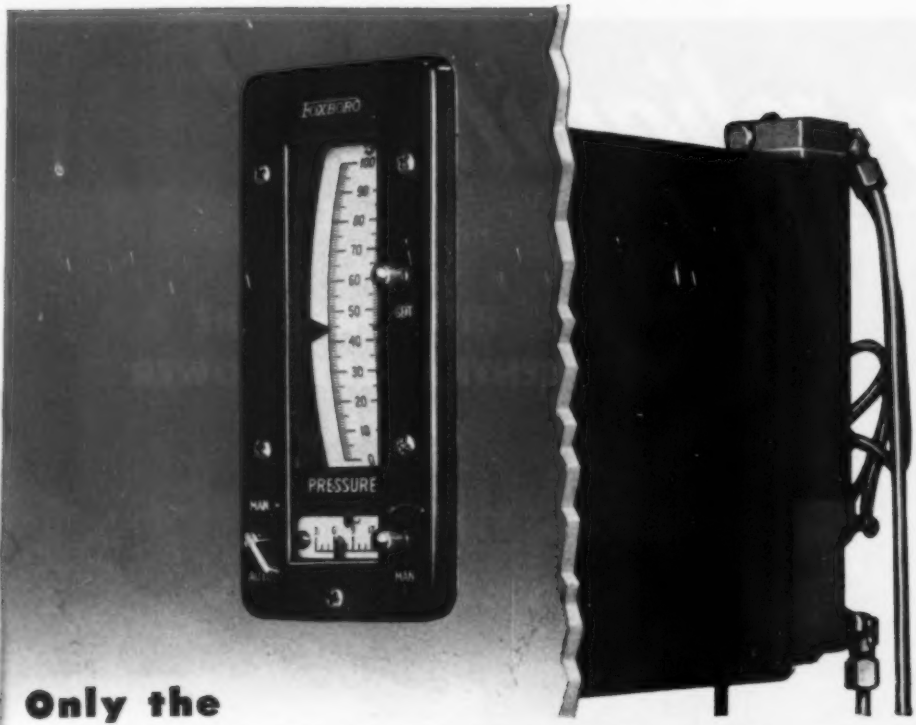


Typical Elliott single-stage blower, for turbine or motor drive.

Company

Centrifugal Blower Dept. • Jeannette, Pa.

DISTRICT OFFICES IN PRINCIPAL CITIES



Only the CONSOTROL M/52 gives you all these advantages!

For indicating control functions in your console or graphic panel instrumentation, no other controller offers so much for so little money as the Foxboro Consotrol M/52 Indicating Controller. Compare these combined advantages:

1. **A completely self-contained, compact, panel-mounted Indicating Receiver Controller** that costs up to 20% less, installed, than usual graphic panel indicating control.
2. **Simple installation** — only 2 connections besides the air supply.
3. **Pull-out feature** that provides complete accessibility of control mechanism from front of panel.
4. **Instrument-type pressure transmitter for driftless** remote manual control, instead of usual pressure regulator.
5. **Simple 2-position transfer switch** and "foolproof" transfer indicator provide absolutely bumpless transfer.
6. **Graphic panel compactness** — takes only 3⅛" x 7⅞" of panel space.
7. **"Full-size" performance** — control action unsurpassed by the finest conventional-size controllers. Available in Proportional, Proportional with Reset, Proportional with Derivative, Proportional with Reset and Derivative, and On-Off.
8. May be used with separately-mounted recorder using conventional circular charts. Up to 6 records may be combined on one chart with the Foxboro Multi-Record Recorder. (Consotrol Recorder-Controllers, featuring full scale 4" strip charts, also available.)

Get full details of this space-saving, cost-saving instrumentation. Write for Bulletin 463 describing the complete Consotrol Line of graphic panel instruments. **The Foxboro Company, 7410 Neponset Ave., Foxboro, Mass., U. S. A.**

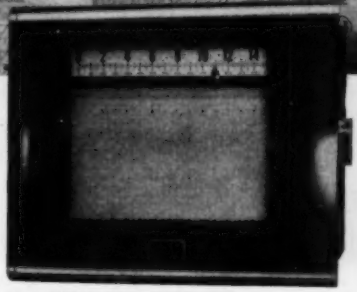
FOXBORO
REG. U. S. PAT. OFF.

RECORDING · CONTROLLING · INDICATING
INSTRUMENTS

and chose the

BRISTOL DYNAMASTER

Continuous-balancing electronic recorder



The instrument makers whose advertisements appear above know that their reputations depend upon the accuracy and reliability of their recorders. They select each component part with scrupulous care.

As the recording unit in their instruments, they all selected Bristol's Dynamaster. When you choose the Dynamaster for your own measuring needs you are assured of the same accurate, precise instrumentation demanded by these instrument makers.

THERE'S A DYNAMASTER FOR EVERY NEED

Available as a bridge or potentiometer, with strip or circular charts, Dynamasters can measure any variable that can be converted into changes in d-c voltage, d-c current, resistance, or capacitance.

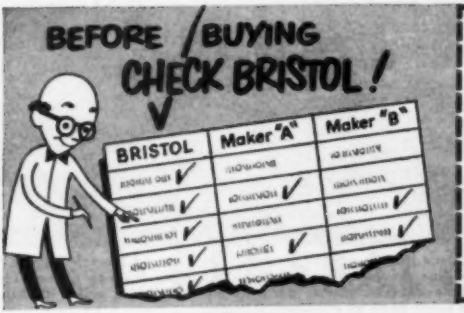
Dynamasters are providing accurate, trouble-free measurement and automatic control of such quantities as temperature, pressure, pH, speed, voltage, power, current, smoke density, strain, and resistance.

BRISTOL

FOR MORE INFORMATION *on the uses of this versatile recorder, use the coupon to get Catalog No. P1245.*

The dependable Guidepost of Industry

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



THE BRISTOL COMPANY
111 Bristol Road
Waterbury 20, Conn.

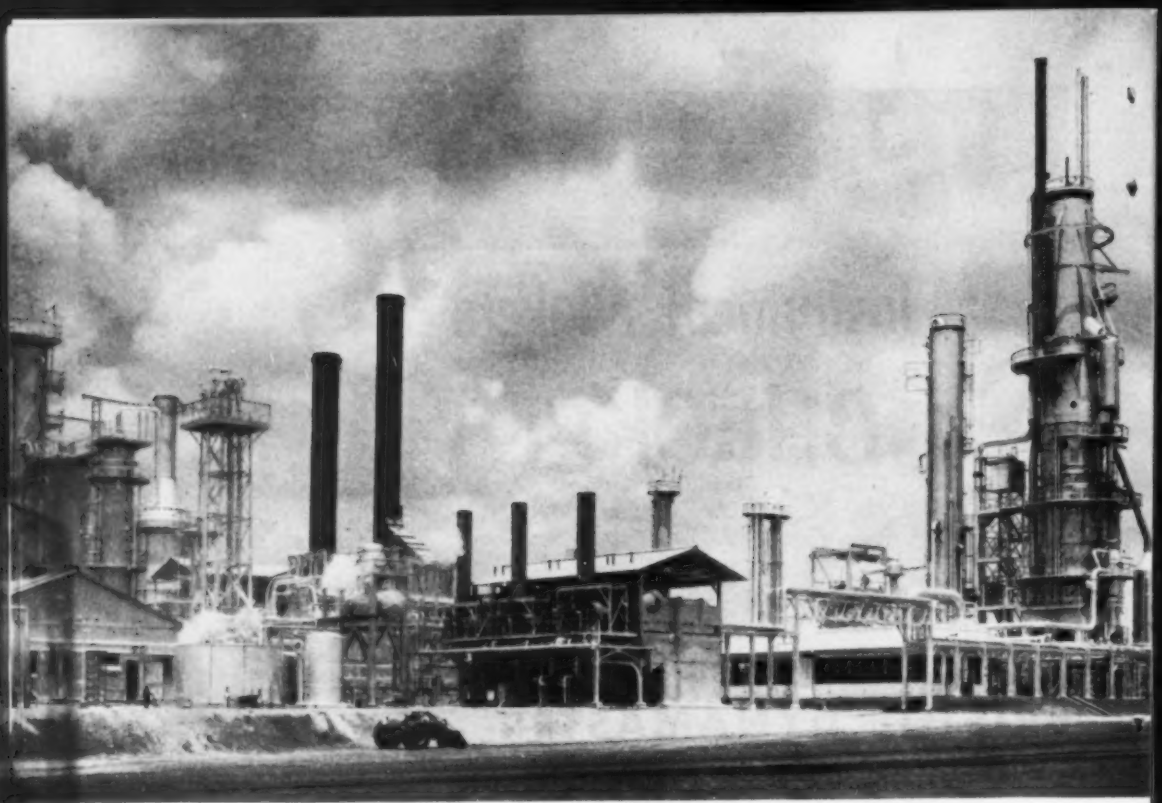
Please send catalog giving details of Dynamaster performance to:

NAME _____ TITLE _____

COMPANY _____

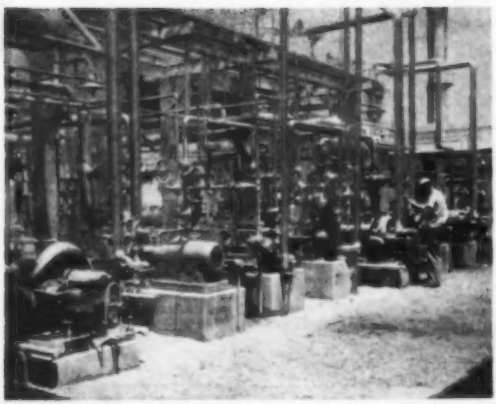
ADDRESS _____

CITY _____ ZONE _____ STATE _____

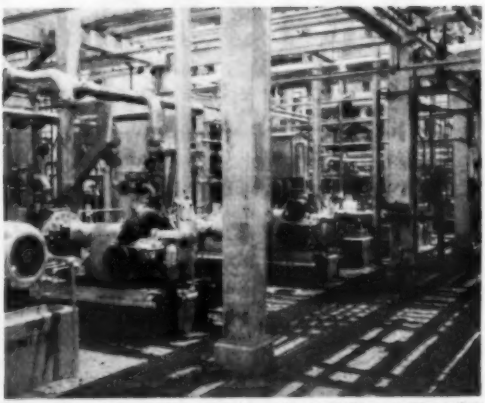


McMurrey Refining Company, Tyler, Texas, installed G-E mechanical-drive turbines throughout their plant to help assure continuous capacity output of 5000 bbls. per day.

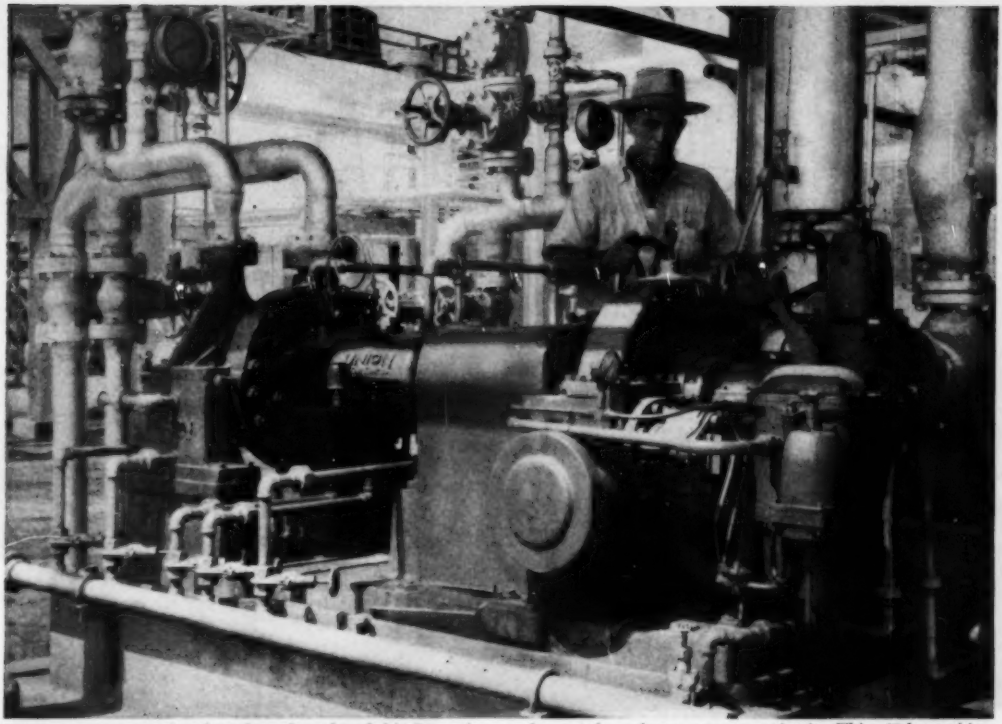
G-E Turbines Save Maintenance,



G-E turbines and motors are paired at McMurrey Refinery to utilize large steam supply efficiently. When process steam demands decrease, surplus steam is economically diverted to turbine drives. These Type DP turbines range from 8 hp to 41 hp.



Shown here is part of a row of ten General Electric Type DP turbine drives and motors, ranging from 9 hp to 48 hp. The many interchangeable parts on these turbines make stocking of spare parts an economical matter.



Maintenance personnel at the refinery have found this General Electric Type DP mechanical-drive turbine, like the many others at the refinery, easy to maintain. This 47-hp turbine at McMurrey Refinery drives a boiler-feed water pump.

Inventory Costs at McMurrey Refinery

Installed to improve steam balance, G-E standard turbines, with many interchangeable parts, also cut inventory costs.

The McMurrey Refinery, Tyler, Texas installed General Electric mechanical-drive turbines to help regulate steam balance. Since process steam demands range from 30% to 70% of available supply, surplus steam is economically diverted to turbine drives.

Time soon proved the many other advantages of G-E turbine drives which were especially designed for the petroleum industry. Mr. Dave Hood, Mechanical Maintenance Foreman at the refinery, states, "With these turbines on the line now for over a year, we're happy to report that they are extremely easy and economical to maintain, requiring very little of our time for maintenance."

Mr. Hood also said, "Since we have quite a few different sizes and ratings of turbines here, we're particularly pleased with the great number of interchangeable parts on these turbines. It certainly cuts down our inventory problem." Interchangeability of a great majority of the replaceable parts (regardless of hp rating) is a big feature with G-E standard turbine drives, which are paired with motors throughout the refinery to help assure uninterrupted service.

Call in your G-E sales-engineer or write for bulletin GEA-4955A, "A New Standard in Mechanical-drive Turbines." Section 252-58, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

33...

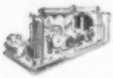
...OR 3

Whether you are planning a large installation of pressure storage or just adding a few individual tanks, Beaird is equipped to meet your requirements.

Fabricating pressure storage vessels has been our business since 1918. Our engineers, plant men, and management, with these years of experience behind them, have an intimate knowledge of how to design and manufacture pressure tanks to meet the most rigid standards. Their personal interest in maintaining high quality is an integral part of every pressure storage tank fabricated by Beaird.

May we quote you on your pressure storage requirements?

THE J. B. BEAIRD COMPANY, INC. **SHREVEPORT, LOUISIANA**



PACKAGED COMPRESSOR PLANTS

L-P GAS SYSTEMS

CAST STEEL FITTINGS

ANHYDROUS AMMONIA EQUIPMENT

MACHINING
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STEEL WAREHOUSE

SINCE 1918
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ENGINEERED FOR SAFE STORAGE

Petroleum refining and chemical manufacturing are industries of almost incredible superlatives. They have spent for new facilities since 1945 a sum roughly equal to total gross plant investment for all prior years. In these accomplishments, The Lummus Company—as design engineers and constructors—was privileged to play a major role.

But the years ahead are apt to make the past look puny by comparison. This year, for example, oil companies will top 1951 capital spending by over a third—chemical companies by nearly a fifth. Preliminary plans through 1955 show little or no relaxation from this rate.

Big job? Lummus is ready—a fact you may wish to bear in mind as mounting demands challenge the already-extended organizations of petroleum and chemical companies.

Rely on the quality and versatility of the Lummus staff—on the proven ability of Lummus to handle, under one contract, the functions of engineering, drafting, purchasing, expediting, inspecting, erection and initial operation.

And—as a policy statement for the record—rely on us to recognize and accept the special responsibility of handling confidential information in accordance with your own best interests and desires.

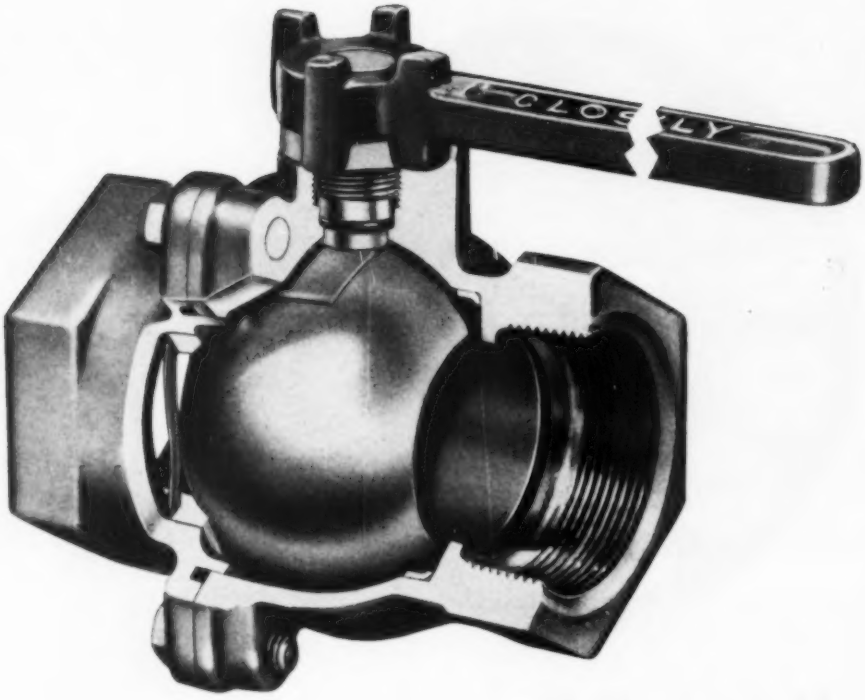
May we work together? We're ready!

THE LUMMUS COMPANY

385 MADISON AVENUE, NEW YORK 17, N. Y.

HOUSTON • CHICAGO • LONDON • PARIS • CARACAS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES



NEW BALL VALVE

gives you more of what you want in a valve

Full round flow... as full as if there were no valve in the pipe at all. Handles fluids with minimum friction loss . . . without turbulence.

Quick opening . . . Quick closing... even under full pressure. Needs only an easy quarter turn.

Resists wear longer . . . chrome-plated floating bronze ball is extremely resistant to scratching, pitting, abrasion.

Stays leakproof . . . When valve is in closed position, pressure of fluid automatically positions ball against synthetic rubber seat to form a tight seal.

DISTRIBUTORS IN ALL PRINCIPAL CITIES

APPROVED BY UNDERWRITERS' LABORATORIES, INC.

Among the many satisfied users of Rockwood Ball Valves are:

Libbey-Owens-Ford Glass Company
Revere Copper & Brass Incorporated
Bird Machine Company
Remington Rand, Inc.
Hub Machine Company
Daggett Chocolate Co.
G. F. Heublein & Bro., Inc.

Send For Free Bulletin, "New Rockwood Ball Type Valves," containing detailed information.

ROCKWOOD

ROCKWOOD BALL VALVES

ROCKWOOD SPRINKLER COMPANY

102 Harlow Street, Worcester 5, Mass.

Why should I buy ZALLEA Expansion Joints?

That is a fair question . . . and here is our answer:

The industrial buyer today is looking more and more closely at the comparative feature-for-feature value of the products he buys.

It has become increasingly necessary for his purchases to justify themselves on the basis of sound business economy—for increased production, economical service, or some other factor.

Expansion joints are no exception in this buying philosophy. That's why we at Zallea Brothers devote our entire efforts to the manufacture of one product—the finest expansion joints it is possible to produce.

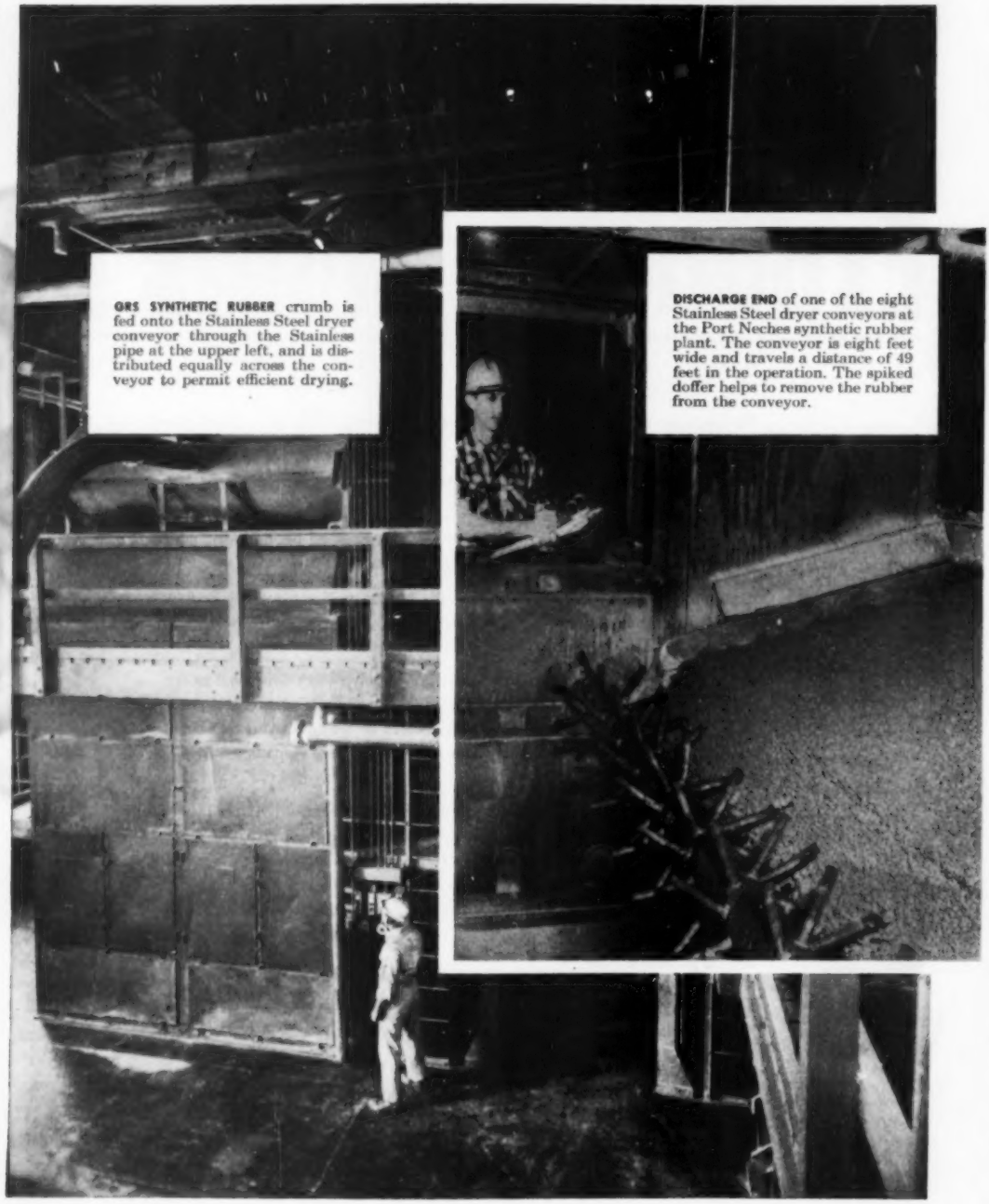
When you buy Zallea Expansion Joints you receive something that never appears on an invoice . . . the *assurance* that you've bought the best! And you'll share this feeling of assurance with thousands of other customers who, for almost a quarter of a century, have relied on Zallea Expansion Joints for trouble-free economical service.

If you'd like to know more, call in your Zallea Representative. He'll be happy to give you complete, helpful information at no obligation on your part. Zallea Brothers, 890 Locust Street, Wilmington 99, Delaware.

Catalog 47 and Bulletin 351 describe the complete line of Zallea Expansion Joints and Flexible Connectors. Write for copies today.

Zallea
EXPANSION JOINTS

For protection against high humidity,



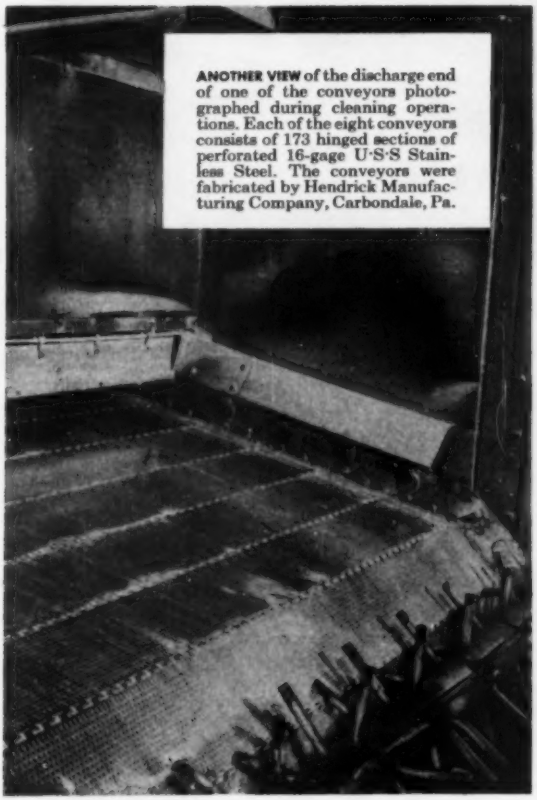
GRS SYNTHETIC RUBBER crumb is fed onto the Stainless Steel dryer conveyor through the Stainless pipe at the upper left, and is distributed equally across the conveyor to permit efficient drying.

DISCHARGE END of one of the eight Stainless Steel dryer conveyors at the Port Neches synthetic rubber plant. The conveyor is eight feet wide and travels a distance of 49 feet in the operation. The spiked doffer helps to remove the rubber from the conveyor.

salt and acid

SYNTHETIC RUBBER CRUMB IS NOW DRIED ON

Stainless Steel CONVEYORS



ANOTHER VIEW of the discharge end of one of the conveyors photographed during cleaning operations. Each of the eight conveyors consists of 173 hinged sections of perforated 16-gage U·S·S Stainless Steel. The conveyors were fabricated by Hendrick Manufacturing Company, Carbondale, Pa.

WHEN the Government's synthetic rubber plant at Port Neches, Tex., was reactivated two years ago, the operator, U. S. Rubber Co., solved the twin problems of corrosion and product contamination in drying operations by replacing existing black iron conveyors with corrosion-resistant U·S·S Stainless Steel.

As wet crude rubber leaves the filter, it contains about 30% water, plus some sulphuric acid and salt not removed by washing. The conveyors carry it into ovens—held at 175°F. This high humidity, salt and acid are highly conducive to corrosion—but not when the conveyors are Stainless Steel.

Stainless Steel has exceptional resistance to the acid and salts in this service. There's no chance of contamination of the finished crude rubber. And the Stainless Steel conveyors can be cleaned more easily and more efficiently.

The service life of the black iron conveyors formerly used was between two and three years. Plant officials expect at least five more years of life from Stainless Steel. The present conveyors have been in operation 126 hours per week over a two year period with no maintenance problems.

The characteristics demonstrated by U·S·S Stainless Steel in this application—excellent corrosion resistance under severe conditions, long life, freedom from product contamination and ease of cleaning—make it the ideal material for many types of petrochemical processing equipment. While the initial cost of Stainless equipment may be higher, its performance makes it far less expensive in the long run.

Our representatives will be glad to discuss the various grades of U·S·S Stainless Steel with you in terms of your applications. When your equipment is fabricated from U·S·S Stainless Steel, you can count on the finest performance.

UNITED STATES STEEL COMPANY, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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VALVE BODIES AND "TRIM" CAST IN AUSTENITIC CHROMIUM-NICKEL STAINLESS STEEL FOR CORROSION RESISTANCE. Produced by Empire Steel Castings, Inc., Reading, Pa., for Kieley and Mueller, Inc., North Bergen, N. J., these stainless steel castings provide 80,000 p.s.i. tensile strength, 40,000 p.s.i. yield strength, 50% elongation, hardness of 156 BHN.

STAINLESS...

For Product Purity at Low Production Cost

Processors from coast to coast are discovering that *chromium-nickel stainless steels* . . . for cast parts in contact with raw materials . . . provide the key to higher quality production.

In addition to an inherent resistance to corrosion, appropriate types of cast stainless alloys permit greatly improved designs, with correspondingly better operating results.

Illustrated is a group of parts cast in austenitic stainless steel containing 19 percent chromium and 9 percent nickel, for fabrication into regulator valves that will assure long, low-cost control of corrosive liquids in petroleum, chemical, paper and many other process industries.

This type of stainless provides outstanding resistance to attacks from many corrosive media, particularly oxidizing acids.

At elevated temperatures austenitic chromium-nickel stainless steels resist creep, scaling and oxidation, while at low temperatures they remain tough and offer exceptional resistance to impact.

Investigate all the economies you may obtain by using stainless steel equipment. Send us your inquiries on the use of cast or wrought stainless alloy steels containing nickel. Write us details of your problems for our suggestions.

At present, the bulk of nickel produced is being diverted to defense. Through application to appropriate authorities, nickel is obtainable for the production of austenitic stainless steels for many end uses in defense and defense supporting industries.

INCO

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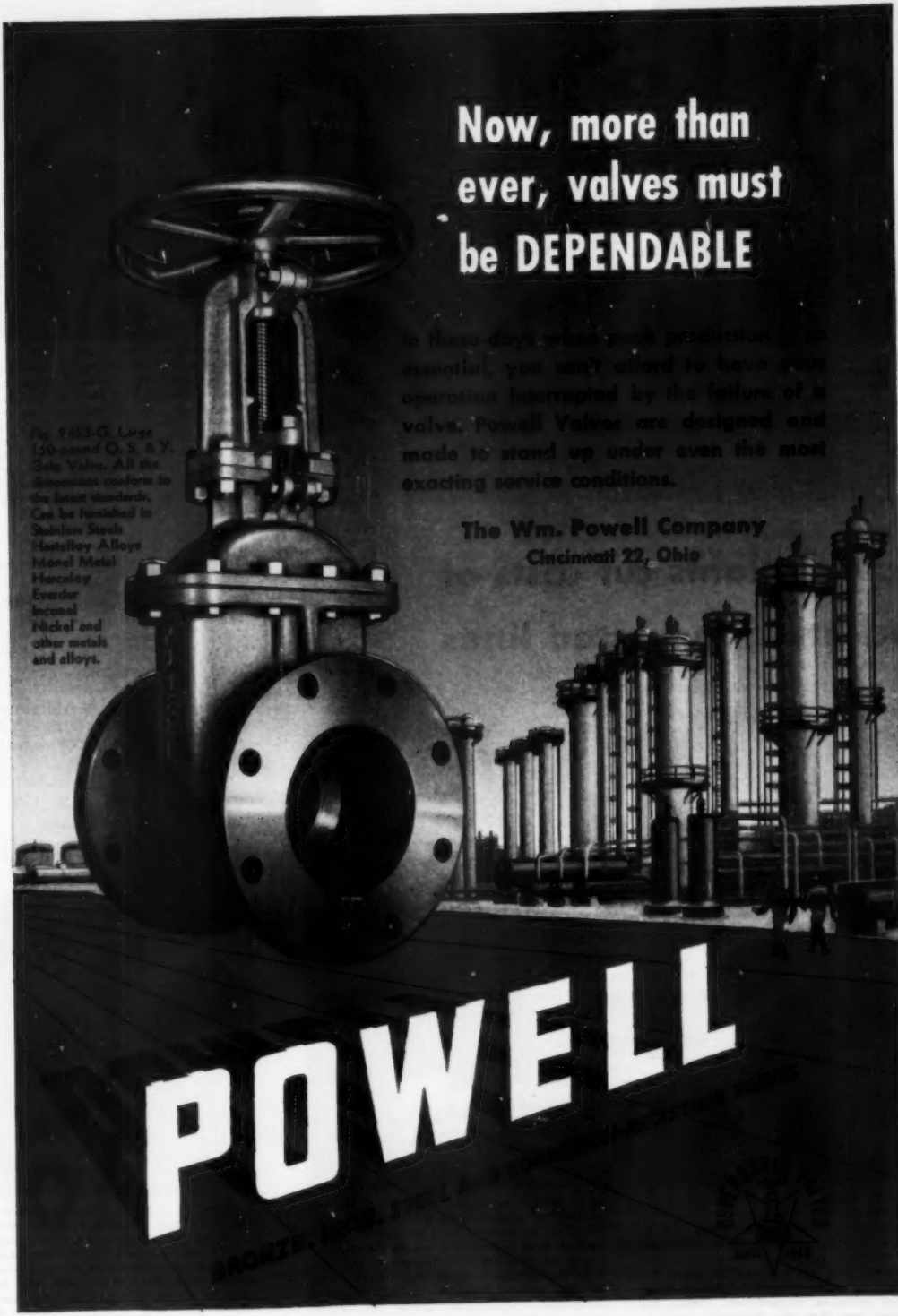
Now, more than ever, valves must be DEPENDABLE
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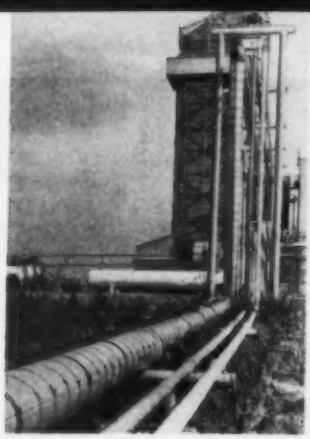
No. 1853-G. Lunkenheimer 150-pound O. S. & Y. Gate Valve. All the dimensions conform to the latest standards. Can be furnished in Stainless Steel Hastelloy Alloys Monel Metal Herculoy Everdur Inconel Nickel and other metals and alloys.
POWELL

This big new Oklahoma refinery has used a new kind of aluminum jacketing throughout on both insulated lines and towers and vessels. Light in weight and low in cost, this new Childers Aluminum Jacketing cut installation costs. It is also expected to cut maintenance costs.



Childers Aluminum Jacketing is used here on a cross-country transfer line at a large chemical manufacturing plant in Texas. This is a rugged test for any jacketing, but the light-weight aluminum used in this jacketing should stand up to weather and chemical corrosion it encounters.

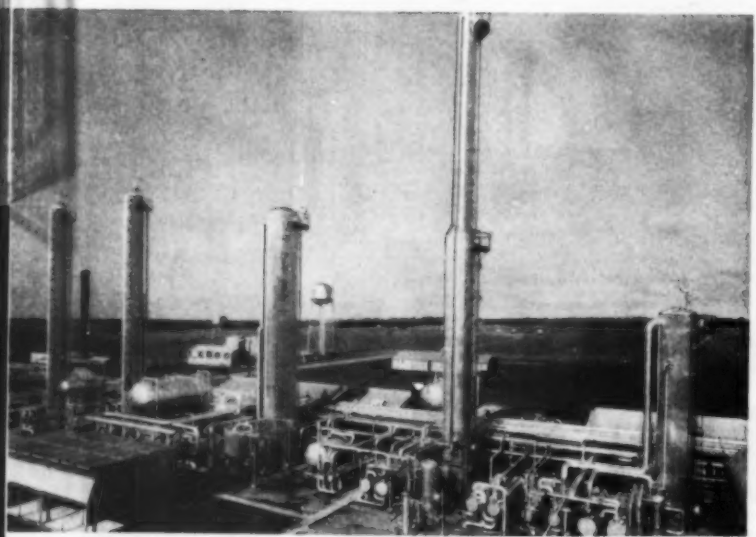
"Good Housekeeping" is the word in this gas pipeline pump station. The insulated lines are handsomely protected by Childers Aluminum Jacketing, which should last as long as the plant itself. The jacketing requires no painting and very little other maintenance. It even allows the interior of the plant to be washed with a hose without harm to the insulation. The chief engineer reports: "We have standardized on Childers Jacketing for all our insulated lines. It is doing an excellent job for us and saving us money."

How 5 plants cut costs of jacketing insulated lines

Weather-resistant, low-cost, easy to put on—these are big reasons for the growing popularity of a new jacketing, specially engineered for insulated lines. It is made of .006" thick aluminum and comes with or without a moisture barrier. It is called Childers Aluminum Weatherproof Jacketing. You can write for a free sample without obligation

Address Childers Manufacturing Co., Dept. PR-12, 3620 West 11th St., Houston 8, Texas.

Under CMP regulations, Childers is a Class B product, the use of which is not restricted.

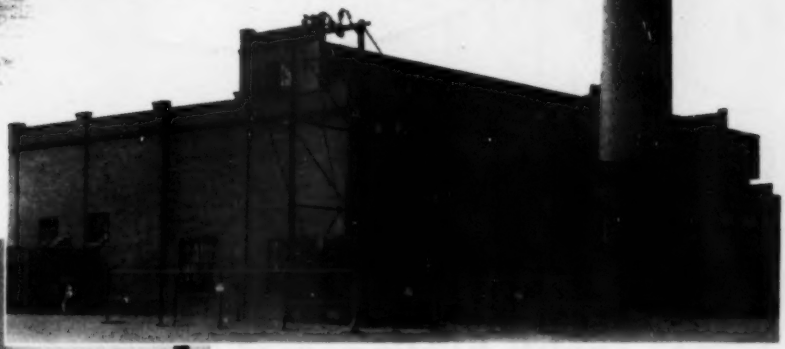


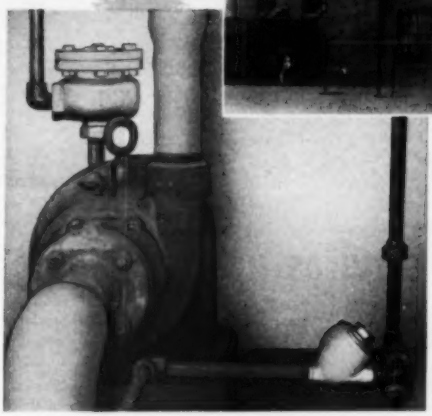
Weather, wind and corrosive gases are not going to attack the insulation of this new plains-country gasoline plant. The insulation is protected by long-lasting aluminum: Childers Aluminum Weatherproof Jacketing. The management expects this low-cost jacketing to hold insulation maintenance costs to a minimum. Other advantages are that the jacketing went on quick and easy during construction; it required no special tools or skill—no shop forming or cutting. It can be taken off and re-used if lines are moved. Aluminum saves on painting and the tough 35 alloy used for Childers Jacketing should stand up for years even in highly corrosive industrial atmospheres. Check the advantages of this jacketing for your own plant.

Amazingly easy to handle, Childers Jacketing was applied here by men using no more than a wooden wedge and a pair of pliers. Childers has engineering representatives in every major industrial center who will be glad to confer with you on your particular jacketing problems. Write to address shown above.

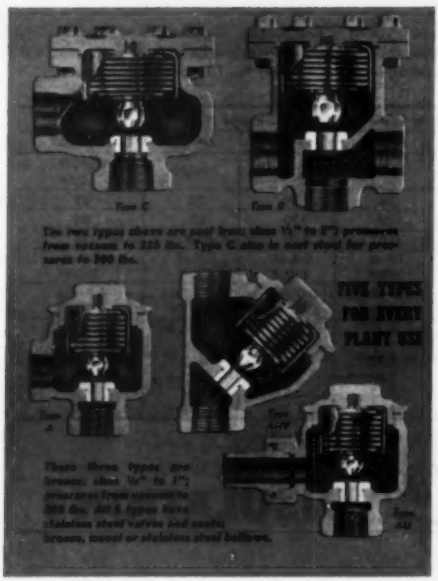
(Advertisement)

NICHOLSON TRAPS SELECTED FOR *Celanese* STEAM PLANT





Above, enlarged steam generating facilities of the Celanese Corporation of America plant at Hopewell, Va., now in an extensive expansion program. Specified were Nicholson Steam Traps, two of which are shown at left.



How to use modern equipment to bring the steam generating capacity of a boilerhouse up to the needs of an extensive plant expansion program was recently demonstrated by Celanese Corporation of America at its Hopewell, Va., textile plant.

Stoker equipment to fit present space, and auxiliary equipment of the most modern nature -- all were selected with a view to attaining maximum efficiency, and desired capacity with a margin of space for further expansion. Nicholson Steam Traps were installed in connection with a new piping system which features return of the condensate and reclamation of most of its heat.

A recent survey showed these Nicholson features to be reasons why an increasing number of leading plants are standardizing on Nicholson thermostatic traps: 2 to 6 times average drainage capacity; shorten heat-up time. Operate at lower temperature differential; fast action keeps equipment full of live steam. Maximum air-venting capacity. Types for every process, power and heat application.

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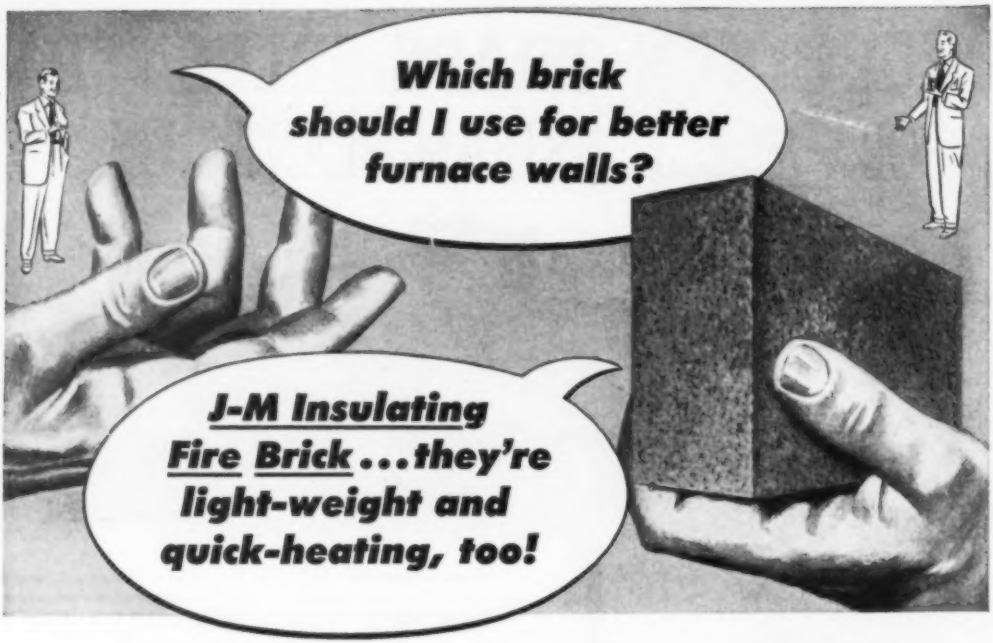

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A Johns-Manville insulation expert will gladly explain the advantages and economies of using J-M Insulating Fire Brick and Fireblok for refractory linings or as back-up insulation behind other refractory protection. Write to Johns-Manville, Box 60, New York 16, N. Y. In Canada, write 199 Bay St., Toronto 1, Ontario.

Properties	Types of Insulating Fire Brick and Fireblok					
	JM-3000	JM-28	JM-26	JM-23	JM-20	JM-1620
Temperature limit	†3000F	†2800F	†2600F	†2300F	†2000F	‡2000F †1600F
Density, lb per cu ft	63–67	58	48	42	35	29
Transverse strength, psi	200	120	125	120	80	60
Cold crushing strength, psi	40	150	190	170	115	70
Linear shrinkage, percent	*0.8 at 3000F	4.0 at 2800F	1.0 at 2600F	0.3 at 2300F	0.0 at 2000F	0.0 at 2000F
Reversible thermal expansion, percent	0.5–0.6 at 2000F	0.5–0.6 at 2000F	0.5–0.6 at 2000F	0.5–0.6 at 2000F	0.5–0.6 at 2000F	0.5–0.6 at 2000F
Conductivity (Btu in. per sq ft per F per hr at following mean temperatures)						
500F	3.10	2.00	1.92	1.51	0.97	0.77
1000F	3.20	2.50	2.22	1.91	1.22	1.02
1500F	3.35	3.00	2.52	2.31	1.47	1.27
2000F	3.60	3.50	2.82	2.70	1.72	....

*24-hr Simulative Service Panel Test; all others 24-hr soaking period. †Back-up or exposed. ‡Back-up only.

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Perfect example

Here is a perfect example of a business in which the service is as important as the product, itself.

There is nothing in the book to stop you from packaging all your lubricants and saying to the car owner: "Here's your grease and oil—put 'em in yourself!"

However, mighty little oil business is done that way. The reason—your business is essentially a *service* business.

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'Way back in 1925 Ethyl people realized that if antiknock compound was ever going to be of great value to petroleum refiners, it had to be accompanied by broad-gauge service. So, over the years, Ethyl has developed many programs of service to the petroleum industry.

(*Continued on next page*)

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Perfect example

(*Continued from preceding page*)

Ethyl services have contributed to every field in which the power of gasoline is utilized—passenger cars, truck and bus fleets, farm tractors and aviation. Our research laboratories have cooperated with oil companies in solving the inter-related problems of fuels, engines and lubricants. Year after year our gasoline testing centers have prepared detailed surveys of gasoline characteristics and made them available to refiners. Powerful advertising and merchandising assistance has been provided to help increase the sale of both premium and regular leaded fuels. Our safety division has worked out methods and equipment for the safe handling of gasoline through all stages of blending and distribution.

And having pioneered all these services, it is natural that Ethyl looks to their continuance on even a greater scale in the future. You can be sure that we will always regard *service* as important as product . . . and maybe even more so!

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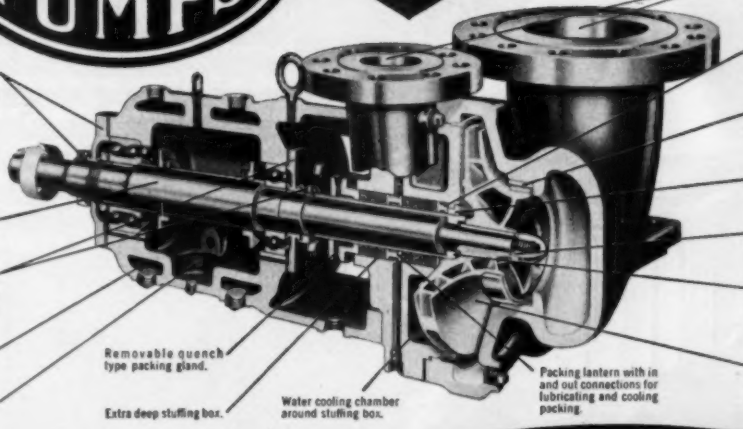
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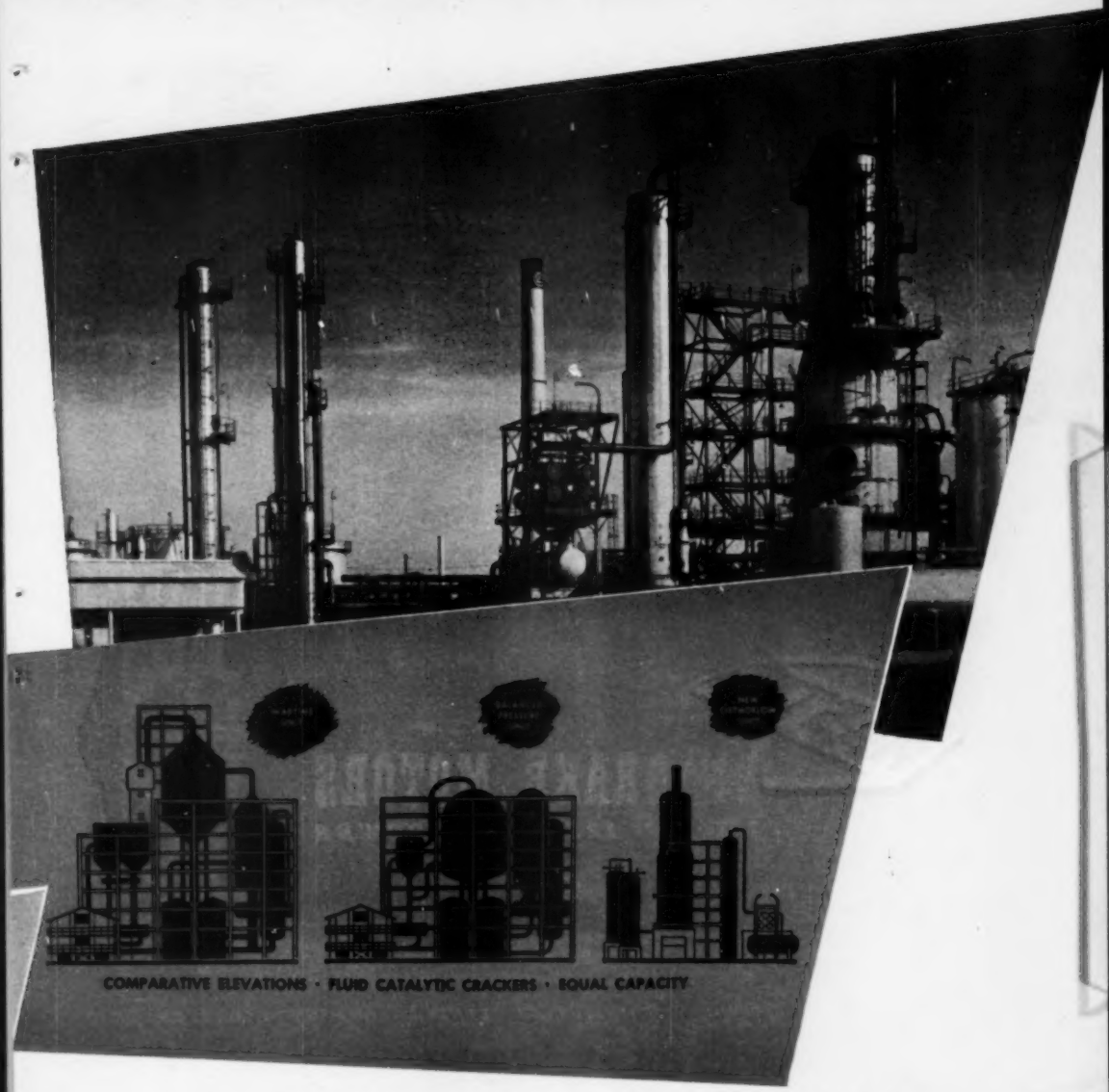
Kellogg Orthoflow



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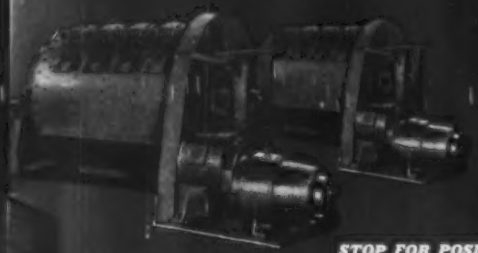

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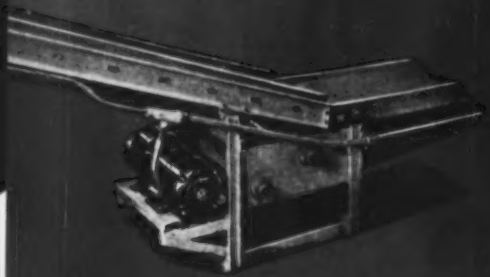

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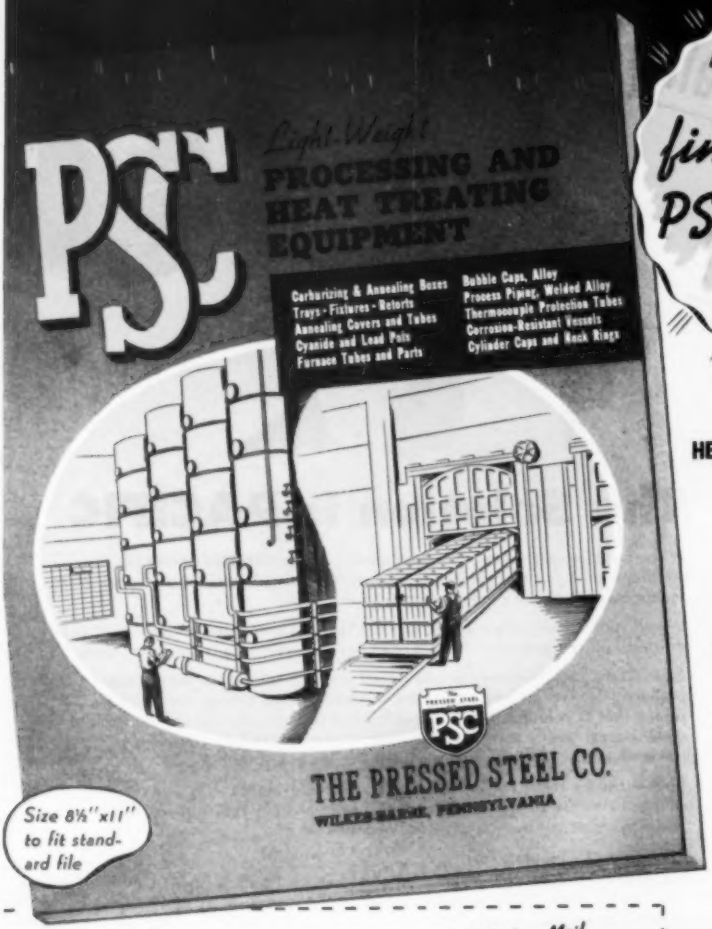

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Boxes, annealing & carburizing
Caps, bubble (fractionating tower & still)
Caps, cylinder (compressed gas)
Covers, annealing (Bell furnace)
Covers, annealing (elevator furnace)
Fixtures, carburizing
Flights, conveyor (syn. rubber plant)
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Racks, sheet pickling
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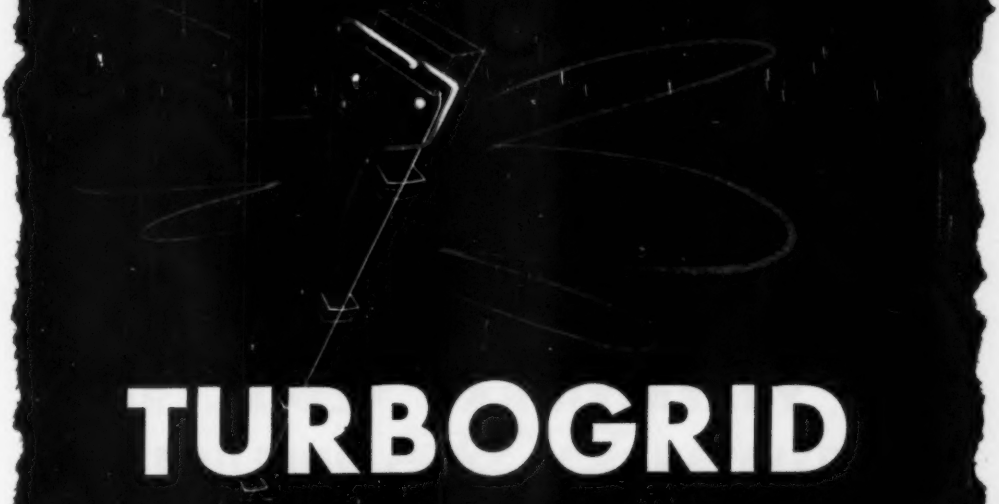
INDUSTRIAL EQUIPMENT OF HEAT AND CORROSION-RESISTANT SHEET ALLOYS

NEW DISTILLATION TRAY



TURBOGRID

the tray that makes the bubble-cap tray obsolete

HIGHER THROUGHPUT is assured when using Turbogrid trays, because they have much higher capacity per square foot of column cross-section at equal separating efficiency and much lower pressure-drop.

The simple, rugged design of this tray assures both **low fabrication and installation costs,** and low costs of maintenance. Also *stainless steel* can be used at *no extra* cost since the tray can be stamped out of sheet metal.

Replacing your old trays with Turbogrid trays may even double the capacity of existing columns without loss in separating efficiency . . . and at a cost which you will find attractive.

• • •

Your inquiries are invited. Turbogrid trays are available through selected contractors under license from Shell Development Company.

SHELL DEVELOPMENT COMPANY

50 WEST 50TH STREET • NEW YORK 20, N. Y.

SHELL

Esso
CONOCO
CITIES SERVICE
UCC
CARBIDE AND CARBON CHEMICALS COMPANY
RPM
D-X
Warren Petroleum Corporation
RCI
TEXACO
DOW
TENNESSEE EASTMAN COMPANY
E. J. LAVINO AND COMPANY
Kodak
SINCLAIR GASOLINE
Wyandotte
SHELL
AMERICAN CYANAMID COMPANY

What do they have in common?

Two things that we know of.

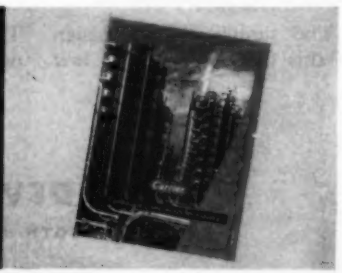
They're all leaders in American industry. *And they're all being served by Carrier Centrifugal Compressors.*

We think that's something you should know. It's one of the most important single facts we can tell you about our centrifugal.

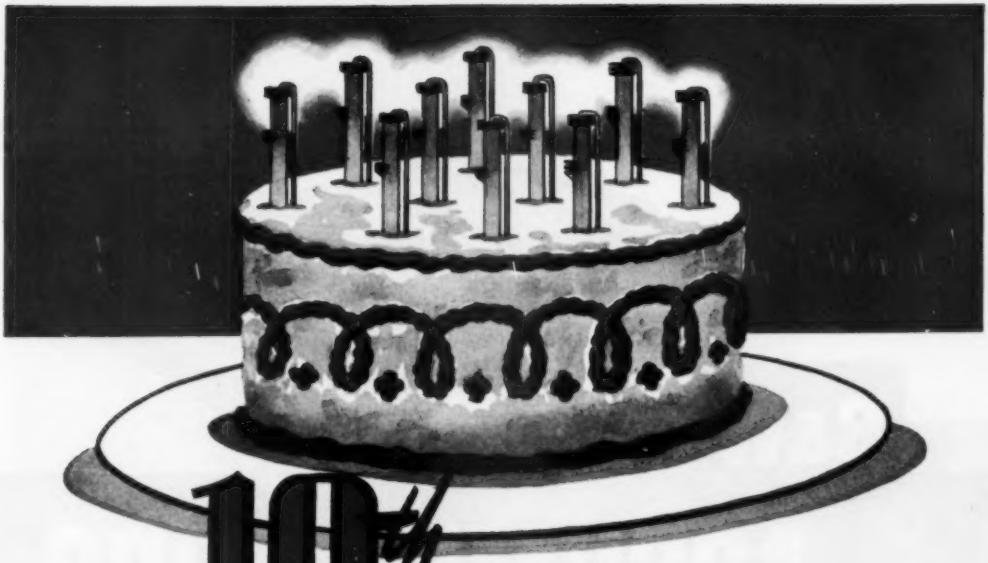
If it impresses you, you'll want to know more, of course. And we have an informative book called "Centrifugal Compressors for Industry" which will tell you a lot more. May we send you a copy? Write Carrier Corporation, Syracuse, New York.

Carrier

CENTRIFUGAL COMPRESSORS
REFRIGERATING EQUIPMENT



Carrier Centrifugal Compressor features, applications, installations and engineering data are among the topics covered in the book, "Centrifugal Compressors for Industry." Write for your copy today.



OUR 10th ANNIVERSARY OF BUILDING *BETTER* REFINERIES

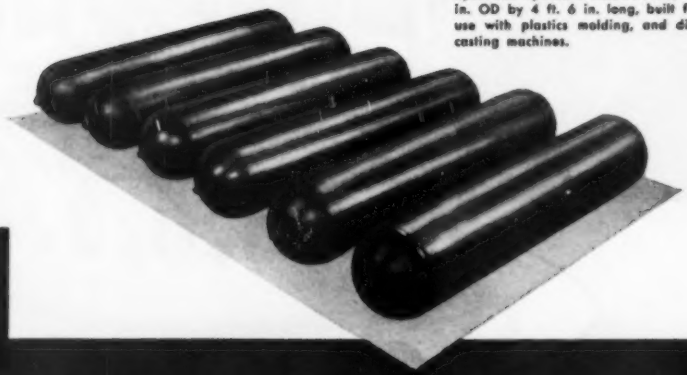
Just 10 years ago, we received our first contract for remodeling the polymerization plant of the Ashland Oil & Refining Company of Ashland, Kentucky. This was followed by other contracts. This year, we have contracts for seven new cat crackers, as well as for other refinery construction. We are proud to state that we have had additional contracts from Ashland as well as nearly all refiners for whom we have done work.

We have just prepared a brochure with information about our company and the work we are doing. Write for a copy on your company stationery, and one will be mailed you promptly.

TRECo

REFINERY ENGINEERING Company

PHONE 5-5561 • TULSA, OKLAHOMA



Spun-end hydraulic accumulators, 14 in. OD by 4 ft. 6 in. long, built for use with plastics molding, and die-casting machines.

B&W ACCUMULATORS

... 500 to 6,000 psi or higher—
5 gallons to 10,000 gallons

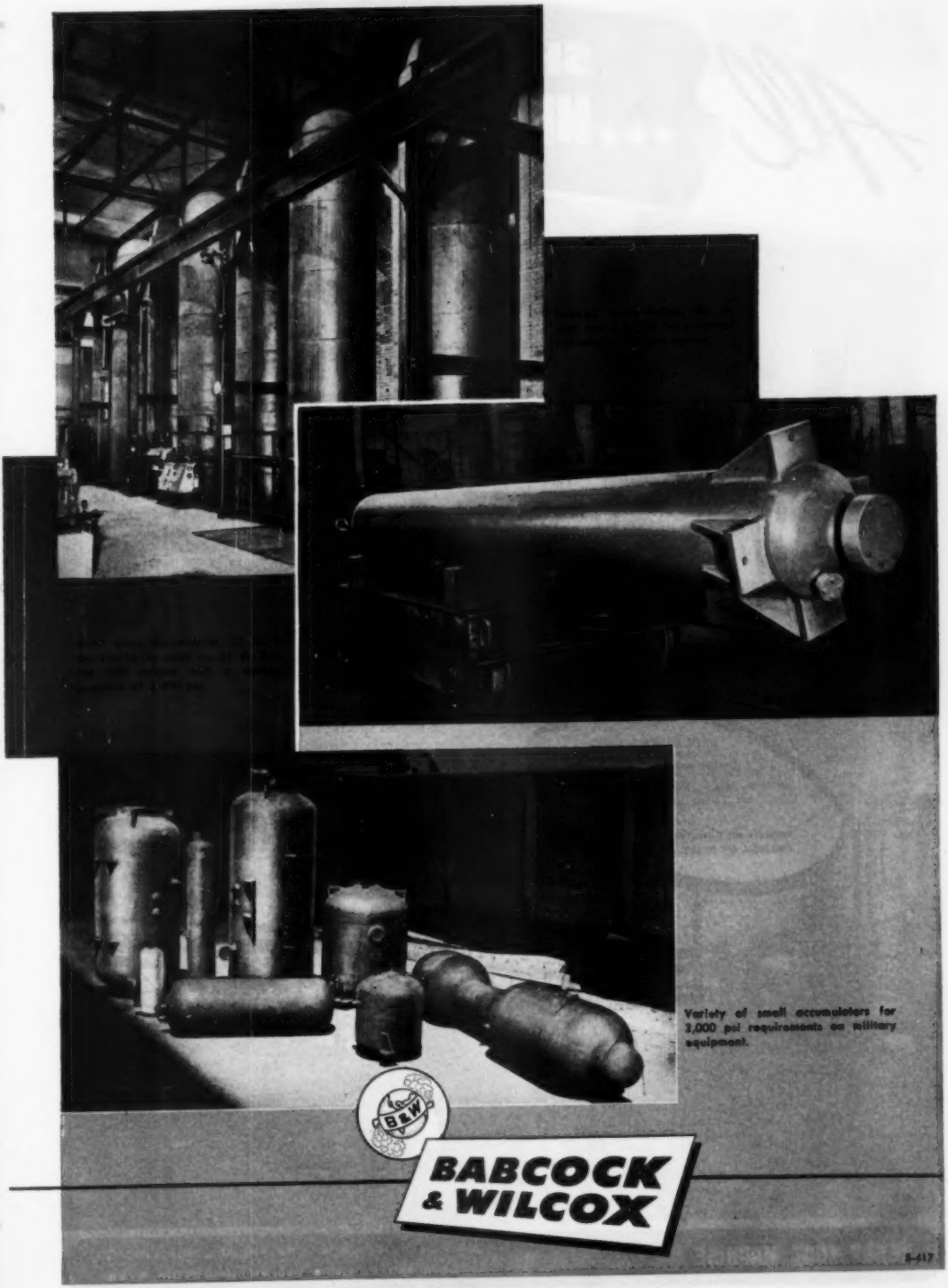
Now serving a broad variety of applications in the processing industries are several hundred B&W Accumulators for working pressures from 500 to as high as 6,000 psi and capacities up to 10,000 gallons. Installations include the three general types described below. Recent additions to B&W's fabricating facilities may permit extension of these pressures to considerably higher values. Every B&W Accumulator is designed and fabricated for utmost dependability and service life.

THREE GENERAL TYPES

SMALL ACCUMULATORS in capacities of 5 to 120 gallons for working pressures of 500 to 5,000 psi.

MEDIUM ACCUMULATORS of solid plate construction, in capacities of 120 to 10,000 gallons; working pressures up to 3,000 psi.

LARGE ACCUMULATORS of B&W banded construction, in capacities from 200 to 9,000 gallons for 2,000 psi and over.



Variety of small accumulators for 2,000 psi requirements on military equipment.

BABCOCK & WILCOX

8-417

All SHELL AND TUBE ...HEAT EXCHANGERS by Vogt

ABOVE: View of new construction at Louisville Refining Company.

BELOW: Some of the many Shell and Tube Exchangers.

Engineered and Licensed by UNIVERSAL OIL PRODUCTS CO.

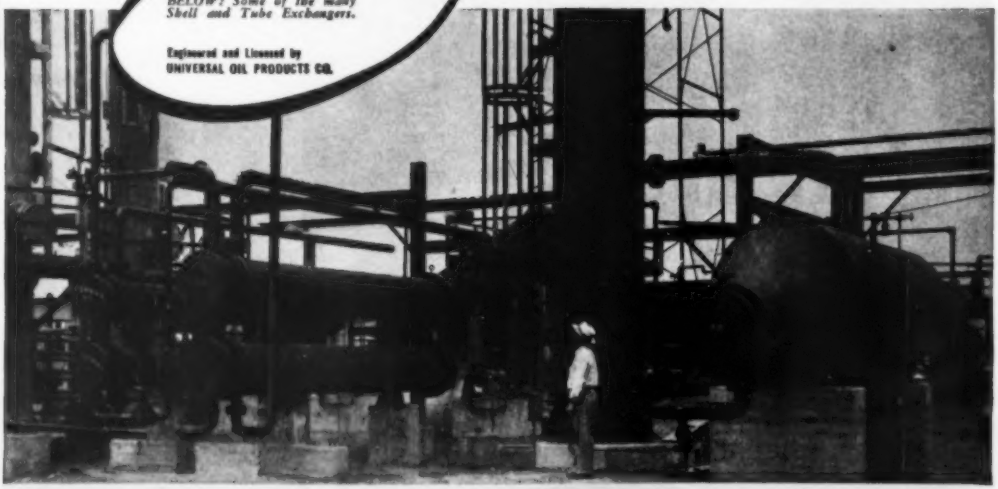
At LOUISVILLE REFINING CO.'S New CATALYTIC CRACKING PLANT

Premium gasoline production has been boosted 20% from the same amount of oil charged since the Louisville Refining Company's new Catalytic Cracking Plant went on stream.

The new plant uses Vogt Shell and Tube Heat Exchangers exclusively and they make a significant contribution to the efficient and economic operations of this progressively modern refinery.

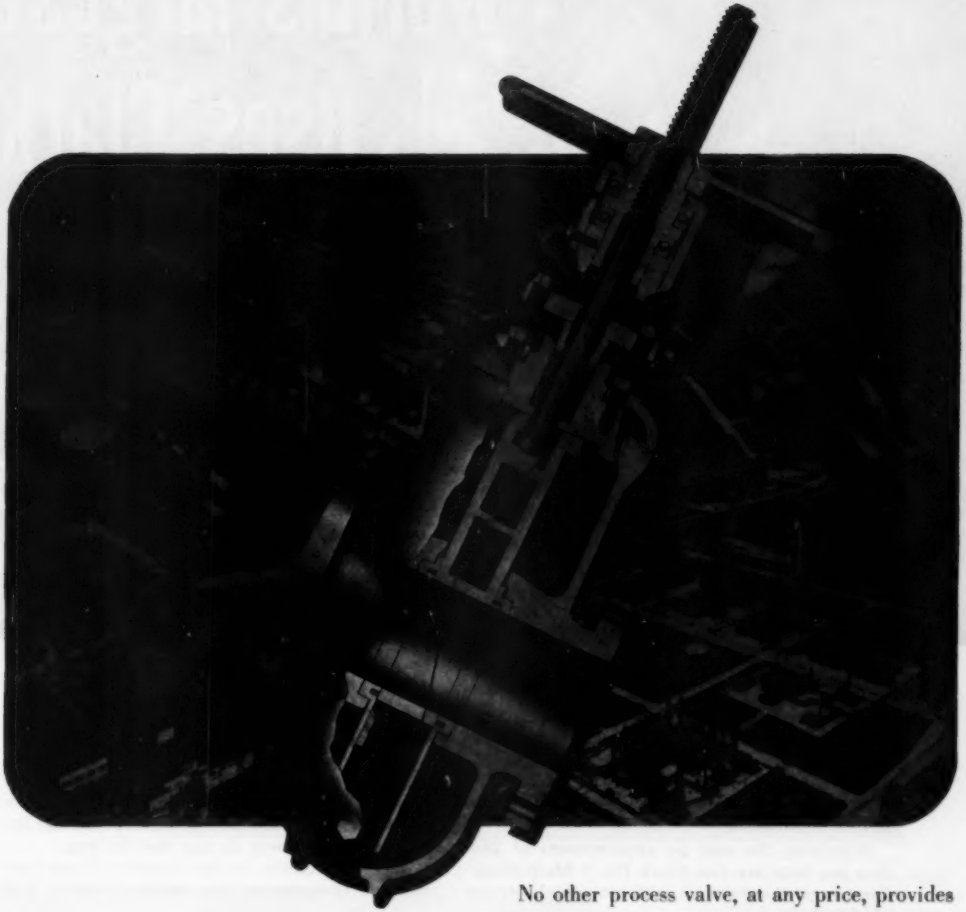
Vogt Shell and Tube Heat Exchangers are available in many different types, with fixed or removable tube bundles, to meet the special problem and specific operating conditions of each installation. They are constructed from carbon and special steels to meet every temperature, pressure, or vacuum service requirement.

WRITE FOR BULLETIN HE-6



HENRY VOGT MACHINE CO. Louisville 10, Ky. • BRANCH OFFICES: NEW YORK, PHILADELPHIA, CHICAGO, CLEVELAND, ST. LOUIS, DALLAS, CHARLESTON, W. VA.

Process Valves by W-K-M



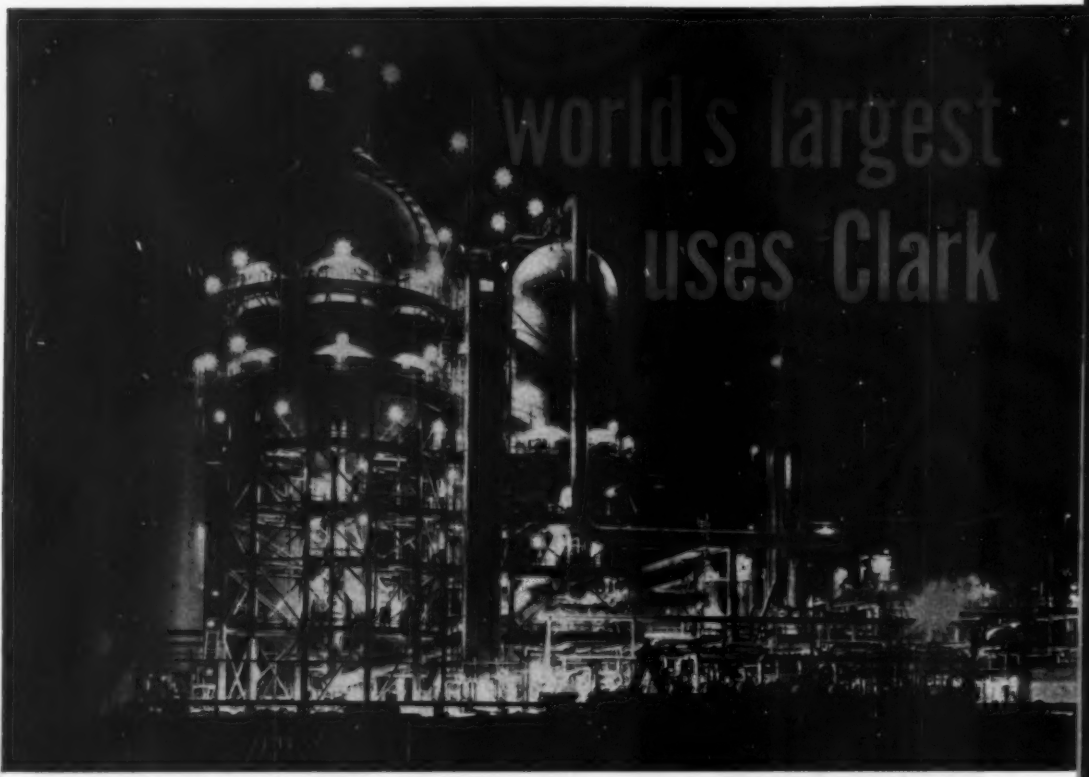
• The performance of W-K-M Valves has been proved in such critical refinery services as fluid catalytic cracking slurry oils and thermal cracking soaking coils; in petrochemical processes for chlorine gas, hydrochloric acid and isopropyl alcohol; and in natural gasoline and cycling plant compressor intake and discharge lines (high pressure), high temperature rich oil, and propane and butane.

No other process valve, at any price, provides so many engineering advantages for efficient operation and maintenance. You can get complete information about W-K-M Process Valves by writing for W-K-M Bulletin 698.

W-K-M COMPANY

P. O. Box 2117, Houston 1, Texas

727 W. Seventh Street, Los Angeles, Calif. Export Office: 30 Rockefeller Plaza, New York, N. Y.



At Port Arthur, Texas, the Gulf Oil Corporation operates the largest fluid catalytic cracking unit of its type in the world. Thru-put of this huge 63,000 bbl. per day cracker is approximately 20 percent greater than any similar installation. *Clark Centrifugal Compressors — five of them — serve it exclusively!*

Supplying the vast air requirements of 280 tons per hour are two Clark No. 5 Multi-Stage Centrifugal Compressors, with individual outputs of 65,000 cfm.

In addition, there are three other Clark Multi-Stage Centrifugal Compressors: two in vapor recovery and one in propane refrigeration service.

While it's significant that Clark Centrifugal Compressors were selected exclusively for this record-breaking unit, it is but one of numerous, recent cat cracker installations in which Clark Compressors are playing a key role. Wherever large volume applications are being considered, it's only natural to go to the leader that can provide *both* centrifugal and reciprocating compressors . . . the leader that can recommend impartially. Clark will do just that for you.

For information on the complete Clark Centrifugal Compressor line, request Bulletin 116.

CLARK BROS. CO. • OLEAN, N. Y.

DIVISION OF DRESSER OPERATIONS, INC.

Sales Offices in Principal Cities Throughout the World

PRECISION BY THE TON . . .

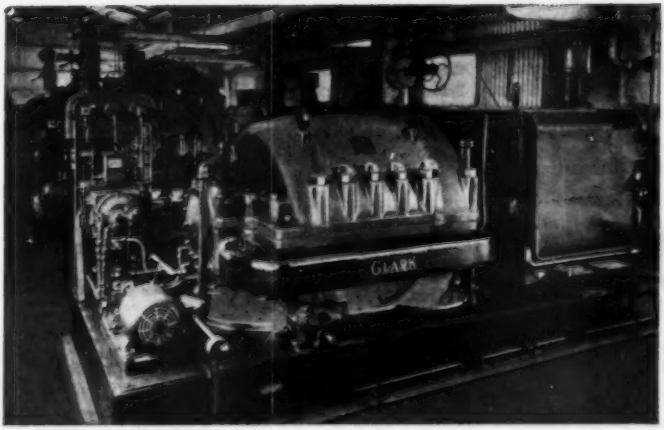
CLARK compressors

GAS-ENGINE-DRIVEN • STEAM-ENGINE-DRIVEN • MOTOR-DRIVEN • CENTRIFUGAL

cat cracker centrifugal compressors

...exclusively

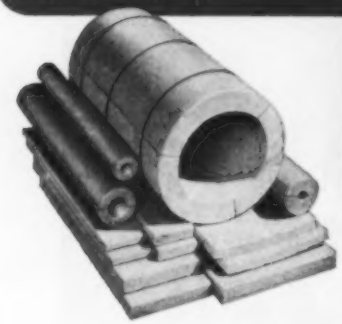
Two Clark No. 5 Multi-Stage Centrifugal Compressors, steam turbine driven, serving as main air compressors for Gulf Oil Corporation's Port Arthur, Tex., cat cracker.



Two No. 3 and one No. 2 Clark Multi-Stage Centrifugal Compressors are used in vapor recovery and propane refrigeration service, respectively.

© 1952, Clark Bros. Co., Division of Dresser Operations, Inc.

Pattern for the Future...



MODERN CONSERVATION PROJECT—the new Snyder Gasoline Plant, Snyder, Texas, operated by Sunray Oil Corp. for some 30 companies and 60 individuals. Plant-process heating equipment and steam lines are insulated with Kaylo Heat Insulation. General contractor—The Fluor Corporation, Ltd., Los Angeles, Calif.; insulation contractor—Industrial Insulators, Inc., Houston, Texas.

Leading Refiners Are Switching to KAYLO HEAT INSULATION

The growing trend to Kaylo Heat Insulation is a logical result of the outstanding combination of advantages offered by this revolutionary heat-saving material.

Kaylo Heat Insulation, a hydrous calcium silicate, has high insulating value over a wide temperature range. It is *effective* up to 1200°F.—thus eliminating the need for combination coverings in nearly all operating conditions.

In addition, Kaylo Heat Insulation has these excellent physical characteristics: it is insoluble in water and incombustible. It has dimensional stability . . . high strength . . . light weight — properties vital to a superior heat insulation.

Its ease of handling, cutting and fitting simplifies application—saves time on the job. With these important extra advantages, *at no extra cost*, little wonder that leading refiners are switching to Kaylo Heat Insulation.

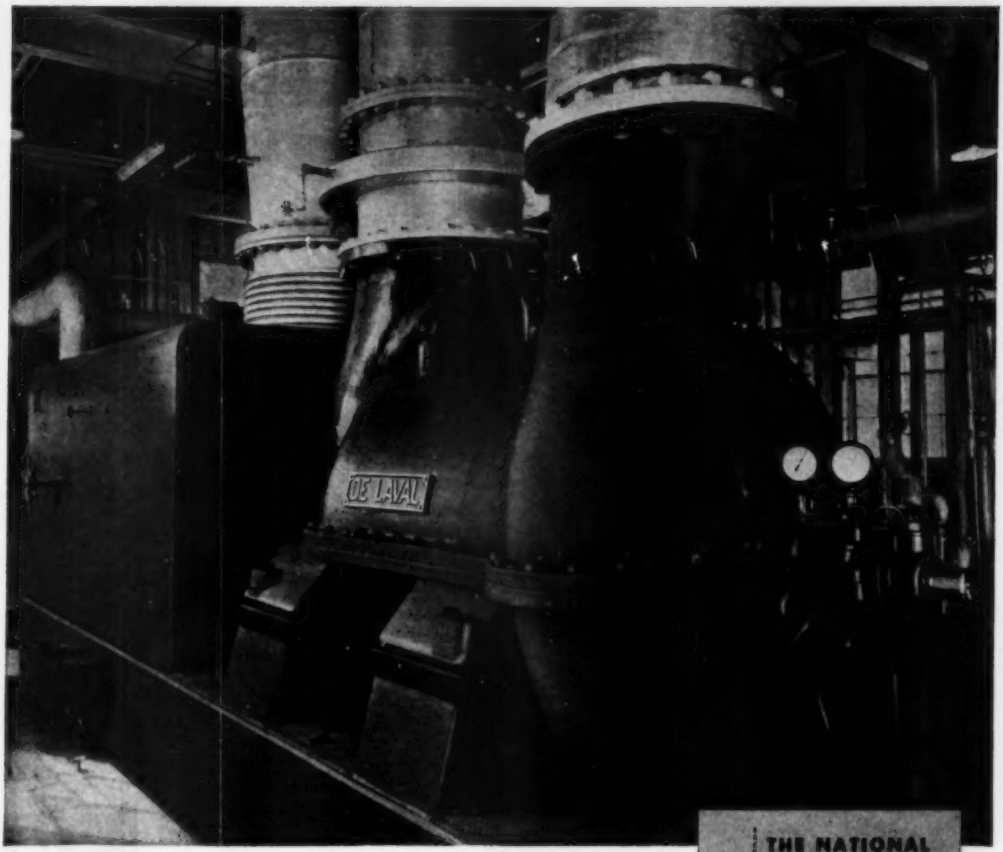
KAYLO . . . *first in calcium silicate*

For complete details on Kaylo Heat Insulation, write Dept. N-245, Owens-Illinois Glass Company, Kaylo Division, Toledo 1, Ohio.

SEE OUR CATALOG IN THE REFINERY CATALOG

...*pioneered by* OWENS-ILLINOIS Glass Company

MAIN OFFICE: TOLEDO 1, OHIO—KAYLO SALES OFFICES: ATLANTA • CHICAGO • HOUSTON • NEW YORK • PITTSBURGH • ST. LOUIS



This blower never takes a "breather"

at THE NATIONAL COOPERATIVE REFINERY ASSOCIATION

There's no time out for this De Laval turbine-driven blower at the McPherson, Kansas fluid catalytic cracking plant of the National Cooperative Refinery Association. Twenty-four hours a day this 21,500 cfm, 2,270 hp unit handles air for regeneration of the spent catalyst.

There are good reasons for this power-saving dependability. This heavy-duty machine is built to take punishment. Its rugged casings, husky, perfectly balanced rotor and externally mounted, cylindrically seated bearings are design features that reduce maintenance and insure continuous operation for long periods of service. And remember, there's no divided responsibility—both turbine and blower are De Laval designed, and De Laval made.

De Laval blower experience covers a wide range of industries — steel, refining, metal mining, chemical processing, high pressure gas transmission, manufactured gas, sewage aeration and many others. And all this engineering and manufacturing experience is ready to solve your specific blower application. Discuss it with a De Laval representative.

DE LAVAL *Centrifugal Blowers*

Send for Bulletin 0500 containing complete data.

DE LAVAL STEAM TURBINE COMPANY
811 Nottingham Way, Trenton 2, New Jersey

PENBERTHY Liquid Level Gages

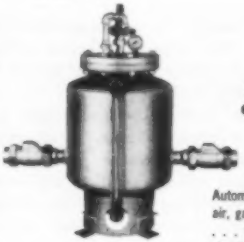
YOU CAN *Remove and Replace Without Shutdown*

Union connections between the gage and the valves permit removal of gage for repairs without shutting down the equipment. Just close the valves, uncouple the unions and remove the gage. The convenience of this is obvious. When glasses have to be replaced or repairs made, it is not necessary to work in an awkward position or to shut down. Another advantage: a gage needing repairs can be replaced immediately by a spare and the repairs made at leisure. There are many other reasons for the superiority of Penberthy Liquid Level Gages; ask for Catalog 35.

OTHER PENBERTHY PRODUCTS

PENBERTHY TRANSPARENT GAGE

Used to observe color and density of liquids under high pressures and/or temperatures. Exceptionally sturdy construction—liquid chamber machined from solid block of metal. Ask for Catalog 35.



PENBERTHY CYCLING JET PUMPS

Automatically operated by air, gas or steam pressure . . . Will pump without clogging any liquid that will flow through pipes. Ask for Bulletin 5030.

PENBERTHY EJECTORS

A simple jet pump operated by air, water or steam. Needs no lubrication . . . will not get out of order. Made in wide variety of materials and special units developed to meet unusual conditions. Ask for Bulletin 512.

PENBERTHY EXPLOSION-PROOF SUMP PUMPS

Motor and switch totally enclosed. Underwriter approved for Class I, Group D, and Class 2, Groups E, F and G hazardous location. Made of copper and bronze throughout. Ask for Bulletin 4929.

4672

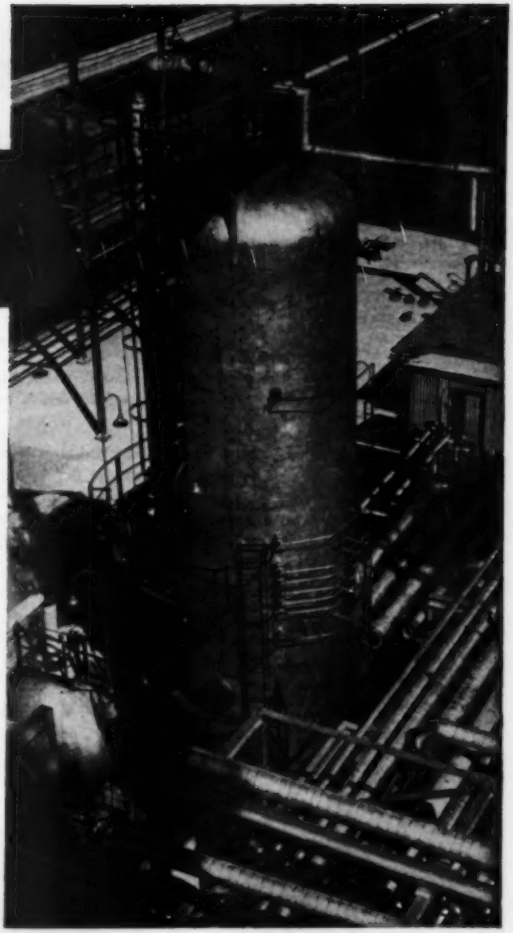
PENBERTHY INJECTOR COMPANY

DIVISION OF THE BUFFALO-ECLIPSE CORPORATION

DETROIT 2, MICHIGAN

Established 1886 — *Canadian Plant, Windsor, Ontario*

5 reasons why TRETOLITE DESALTING is a good investment



1 Tretolite Desalting is a good investment because it need not be a *large* investment. The Tretolite process utilizes conventional refinery equipment, often permitting a plant to be put in operation by using only existing refinery equipment.

2 Tretolite Desalting achieves effective desalting with minimum treating procedures. The Tretolite desalting chemicals, at low ratio, are added by means of a conventional chemical pump to the charging crude. The salt-bearing crude and fresh water are heated, mixed, emulsified, and passed into the settling drum. The salt-bearing water is drawn off; the desalted crude passes on into the refinery charge.

3 Tretolite Desalting not only removes salt with removal efficiencies of around 90%, it also separates insoluble solids such as sand, shale, drilling mud, etc., thereby preventing their accumulation in refinery equipment upstream.

4 Tretolite Desalting is backed by a Desalting Service Staff. Tretolite Desalting Engineers are available to assist any refiner, from a preliminary salt survey through the plant construction, start-up and continuing operations. Mobile test equipment can be moved right into your refinery for an accurate estimate of expected desalting performance.

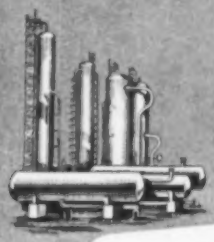
5 Tretolite Desalting is adaptable to any size refinery. Plants now in operation are efficiently handling streams from as small as 2,000 barrels per day to as high as 50,000 barrels per day. Over a million barrels of crude per day are being desalted by Tretolite.

When you invest in desalting, be sure you get the most desalting for your desalting dollar. Your inquiries are welcomed, and will receive prompt attention.

TRETOLITE COMPANY

DESALTING • CORROSION INHIBITING
DEHYDRATING • SCALE PREVENTING
WATER DE-OILING

TD 52-1



DESIGNED FOR PRESSURE... PRODUCED FOR PERFORMANCE

PRECISION RUGGEDNESS OF MIDVALE PRESSURE VESSELS OFFER UNFAILING SERVICE...INCREASED PRODUCTION

Small vessels to withstand extra high pressures, or one of the largest forged steel high pressure vessels as shown below . . . Midvale makes them all.

Precision control from the melting of the steel to the final machining is one of the secrets of the dependable service in every Midvale pressure vessel. Close cooperation of Midvale engineers in designing and building assures satisfactory operation of the finished vessel. That's why leaders in the chemical, refining and processing industries specify Midvale for pressure vessels.

Whatever your specifications you'll find Midvale's skilled craftsmen with their modern facilities and years of experience can build to your design or specification one piece hollow forged bodies of carbon, alloy or stainless steel.

THE MIDVALE COMPANY

NICETOWN • PHILADELPHIA 40, PENNA.
Offices: New York, Chicago, Pittsburgh
Washington, Cleveland, San Francisco

MIDVALE

Custom Steel Makers to Industry

PRODUCERS OF FORGINGS, ROLLS, RINGS, CORROSION AND HEAT RESISTING CASTINGS

Struthers Wells

Fired Heaters

For heating liquids and gases

For indirect heating using circulating medium

The Struthers Wells fired heater is designed to give efficient and trouble-free operation in a wide range of services.

Moderate rates of heat input, symmetrical arrangement of tubes, and the liberal heat absorption surface provided, eliminate overheating of the equipment or the heated fluid.

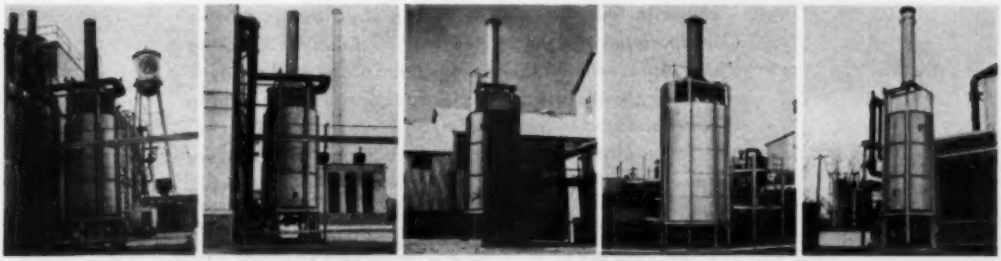
High thermal efficiencies are secured; the convection section surface is provided with heavy welded fins.

Equipment is provided with all necessary accessory and control equipment if required; close temperature control may be secured.

This equipment is being widely used in the chemical and petroleum industries for heating air, hydrocarbon gas and steam to high temperatures, for indirect heating utilizing Dowtherm, and for direct heating of absorption oil, asphalt and many other fluids.

Good deliveries are available in a wide range of standard sizes.

Typical Installations



Write for Bulletin B-45 on your letterhead, please

Struthers Wells

STRUTHERS WELLS CORPORATION
WARREN, PA.
Plants at Warren, Pa. • Titusville, Pa.
Offices in Principal Cities

model IV

fluid catalytic cracking

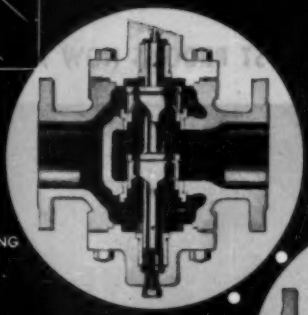
Lower in first cost . . . compact in structure . . . flexible in operation . . . the Model IV Fluid Catalytic Cracking unit represents the latest application of the fluid catalytic cracking principle for the production of high-octane components for both motor and aviation gasolines.

Seven Model IV units in seven different countries are now being designed and constructed by Foster Wheeler.

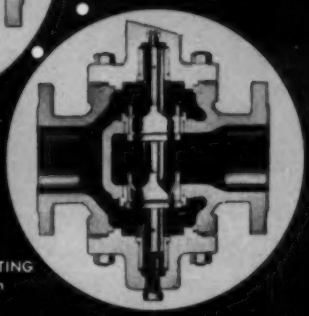
FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

QUICK SHIFT

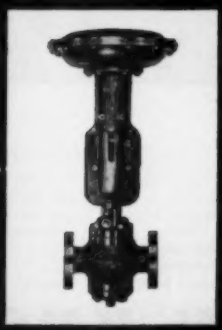


DIRECT ACTING
air to close



REVERSE ACTING
air to open

for easy field reversal of valve action



You can reverse the control action of the Honeywell Series 700 Valve by inverting the valve body and disc, and turning the travel indicator plate to its reverse side. It can be done in the field . . . easily and quickly, without extra parts or complex adjustments.
The Honeywell Series 700 wide band proportional control valve comes in a full range of styles and sizes . . . has *all* the features you look for in a fine valve.
Write today for your copy of Bulletin 700-2.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division,* 1907 Windrim Avenue, Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
VALVE PRODUCTS

H
HONEYWELL

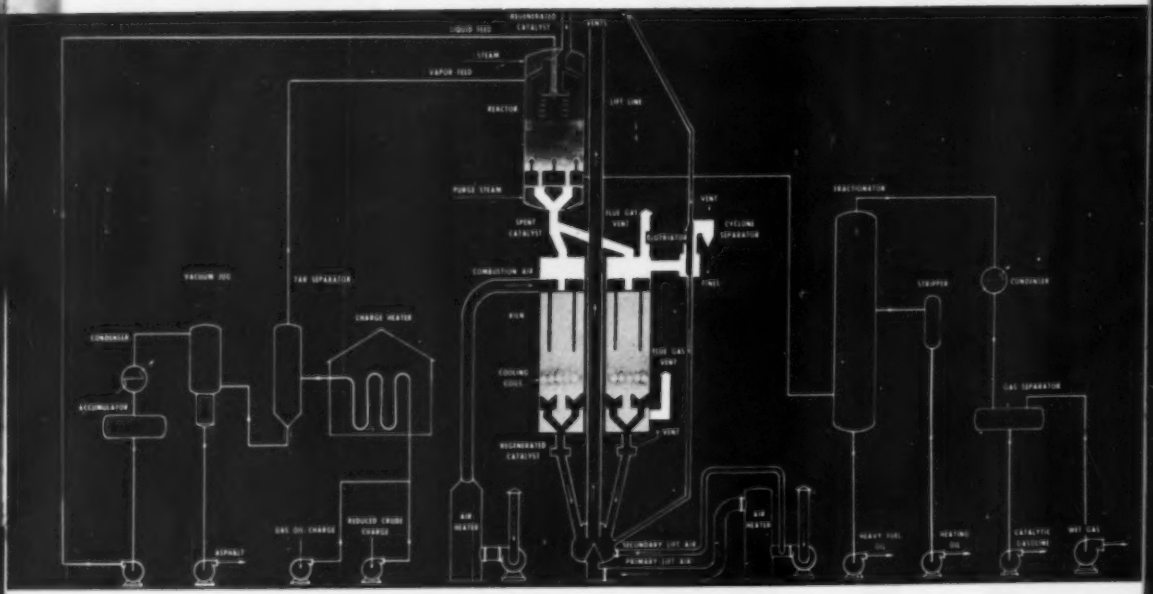
First in Controls

BLAW-KNOX is licensed and equipped to build

TCC

Thermofor Catalytic Cracking Plants

THE HIGH-OCTANE, LOW-COST PROCESS NOW AVAILABLE TO ALL PETROLEUM REFINERS



There's no doubt about the high efficiency of Socony-Vacuum's TCC process but, until very recently, the investment required made it "off limits" for all but the largest refiners. Today it's a different story. Through redesign and the elimination of much field construction, all items of equipment are now prefabricated and shipped direct to the plant site and put in place with speed and economy—bringing the cost per barrel capacity down to that for larger TCC units. The engineers of Chemical Plants Division will be glad to discuss the possibilities of a TCC plant for your operation and profit.

Chemical Plants Division has wide experience in:

Catalytic Cracking	Crude Distillation	Super Fractionation
Catalytic Reforming	Asphalt	Petrochemical
Polymerization	Natural Gasoline Plants	Low Temperature Processes
Alkylation	Sulfur Recovery	Oxyl
Coking	Dehydration	Oxo
Vapor Recovery	Amine Treating	Chlorine

BLAW-KNOX

CONSTRUCTION COMPANY
CHEMICAL PLANTS DIVISION

120 EAST NINTH STREET, TULSA 10, OKLAHOMA

PITTSBURGH 30 • PHILADELPHIA 3 • BIRMINGHAM 3 • NEW YORK 17 •
CHICAGO 1 • WASHINGTON 5, D.C. • SAN FRANCISCO 5

Thirtieth Anniversary

TULSA

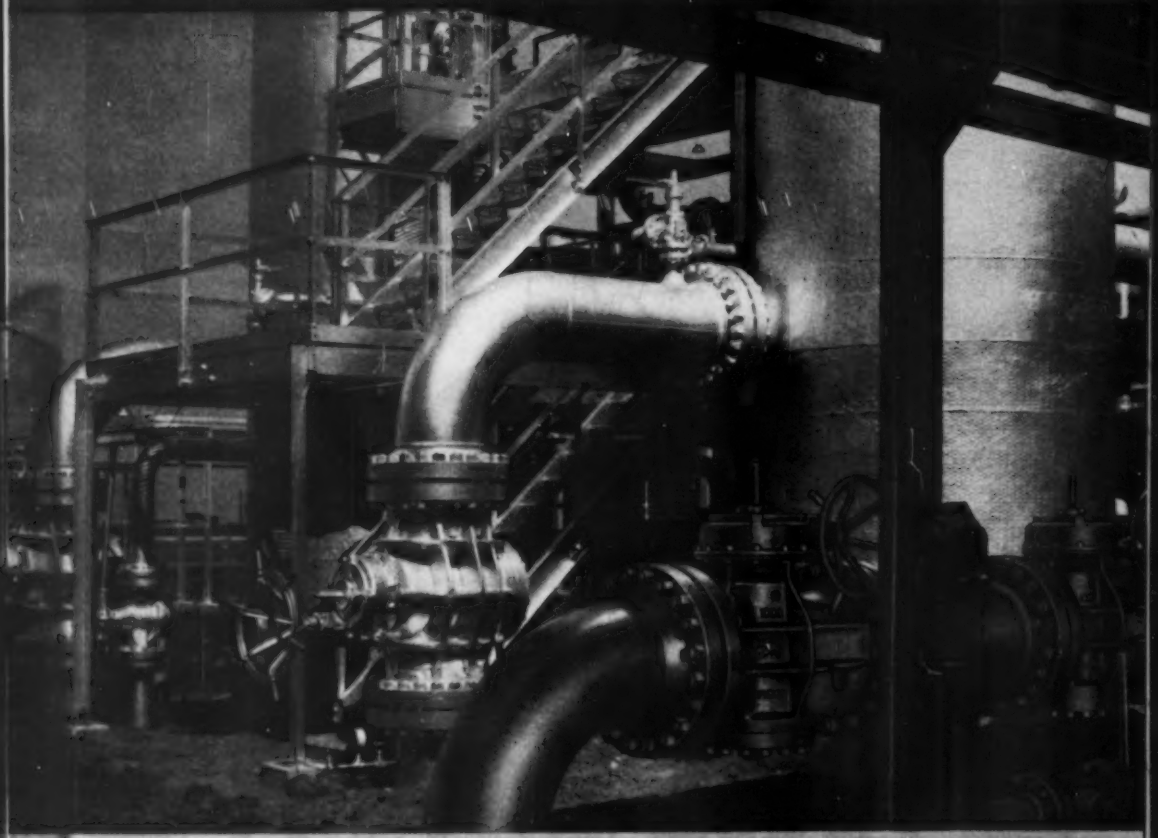
MAY 14-23
1953

EXPLORATION
DRILLING
PRODUCTION
PIPE LINE
REFINING
SCIENTIFIC

To Those Who Will Attend

Requests for accommodations should be sent as soon as needs can be determined. Address: International Petroleum Exposition Housing Bureau, 616 South Boston Avenue, Tulsa, Oklahoma.

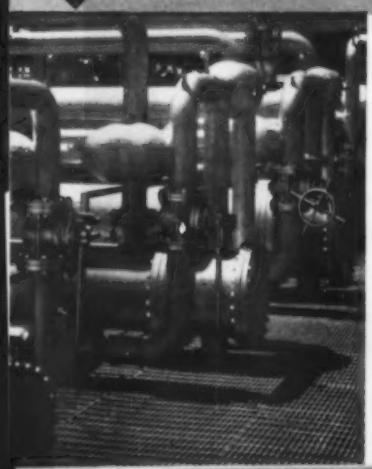
IT'S EASY TO FIT THE RIGHT

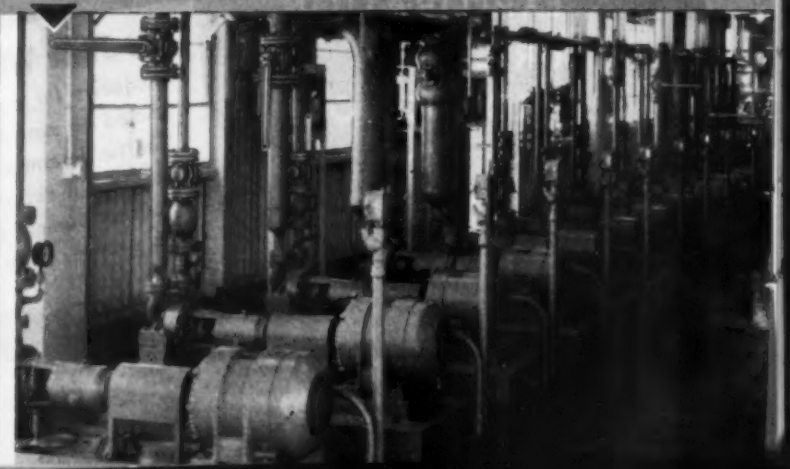


SPECIAL APPLICATIONS Nordstrom experience can tell you what special refinery applications you can successfully make with Nordstrom valves.

INSIDE OR OUT The same characteristics that make Nordstroms the most economical valves for unusual line conditions make them the best bet on inside equipment lines.

ALL SIZES There's a Nordstrom valve in the right size, the right pressure class, the right metals, the right end connection, and the right lubricant for nearly every refinery or gasoline plant service.





VALVE TO

Gasoline Plant and Refinery Services

With the background of several hundred thousand Nordstrom valves in refinery service around the world, Nordstrom engineers can help you select the best, most efficient designs for each type of refinery operation.

Nordstrom valves are especially suitable for refinery lines. The extra seal of plastic lubricant around the seat port area protects seating surfaces against line fluid, and at the same time gives a hydraulic jacking action for easy opening where line conditions cause many valves to stick.

For nearly all complex, hard-to-control refinery line fluids there are suitable Nordstrom valves. These are typical Nordstrom services:

HANDLING HYDROCARBONS—Loading rack, marine terminals, general transfer and run-down lines and other applications throughout the refinery where light hydrocarbons are the line fluid.

CHEMICAL TREATING—Handling treating acids, caustic, Doctor Solution, copper chloride and other reagents, in continuous or batching processes. Special metals are available.

LUBE OIL TREATING—Selective solvent treating of lube oils, including treatment with phenol, etc., along with the deasphalting of oils with propane, methyl ethyl ketone and other methods.

REFINERY GASES—In unit operations or compressor plants, Nordstrom lubricant-sealed valves are generally preferred.

AVIATION GASOLINE PRODUCTION—Manufacture of alkylate for making high octane gasoline, either by the sulphuric acid process or anhydrous hydrofluoric acid process. Special metals, packings and flow area facings are available.

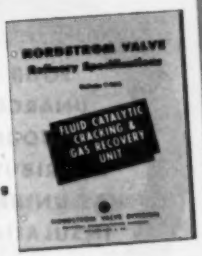
WATER SERVICES—Condenser service, water process lines and power plant lines.

AIR LINES—All types of air service lines.

PETRO-CHEMICAL MANUFACTURE—Examples: phthalic anhydride, isopropyl alcohol, synthetic glycerine, synthetic ethyl alcohol, napthenic acids and other petroleum based chemicals.

Now You Can Easily Fit Nordstrom Valves to the Specific Services in Your Specific Refining Process

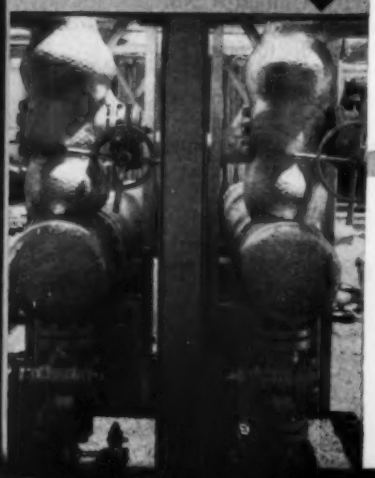
So that refinery engineers can select the proper Nordstrom Valves for each service in the principal refining processes, a series of specification sheets showing recommended materials, pressure classes, lubricants and valve figure numbers has been prepared. There is a special Nordstrom Specification Bulletin for each of these processes:



- Catalytic Polymerization
- Crude Topping and Vacuum Distillation
- Cycloversion
- Delayed Coking
- Distillate Recovery in Cycling Plants
- Duo-Sol Solvent Extraction
- Fluid Catalytic Cracking and Gas Recovery
- Girbotol Process
- Houdriflow Catalytic Cracking and Gas Recovery
- Hydroforming Process
- Light Ends Fractionation
- Naphtha Polyforming
- Phenol Extraction
- Propane Deasphalting
- Propane Dewaxing
- Selexol Process
- Solvent Dewaxing
- Thermal Cracking
- Thermal Reforming

A Nordstrom service engineer will be glad to review these specification sheets with you. Call your nearest Rockwell office or write to Rockwell Manufacturing Company, 400 N. Lexington Ave., Pittsburgh 8, Pa.

EASY STANDARDIZATION Because Nordstrom builds such a wide range of types and sizes, with wrench, geared or automatic operation, you can standardize on them throughout the refinery or gasoline plant.



There's an oil field supply store with Nordstrom Valves and Nordstrom Service as close as your telephone.

Rockwell Built

Nordstrom Valves

Lubricant Sealed to Keep Upkeep Down

Another ROCKWELL *Product*

ROCKWELL MANUFACTURING COMPANY
400 N. Lexington Ave., Pittsburgh 8, Pa.

UNIBESTOS®

YOUR UNARCO WAREHOUSING DISTRIBUTOR HAS UNIBESTOS INSULATIONS IN STOCK

From coast to coast, from north to south, Unibestos is winning new friends. First, because this quality insulation is economical, efficient, long-lasting. Second, because—wherever you are—there's a reliable distributing organization ready to supply you from stock. For temperatures up to 1200° F., specify Unibestos No. 1200. Ask for Unibestos No. 750 when the temperature won't go over 750° F. And, for needs up to 600° F., you can get Unarco Amocel from these same Warehousing Distributors. Unibestos is made in cylinders, half-rounds, and blocks. If you don't know your nearest Unarco Distributor, we'll be glad to send you his name. Please ask us, too, for Bulletin 76-109.

UNARCO

UNION ASBESTOS & RUBBER COMPANY

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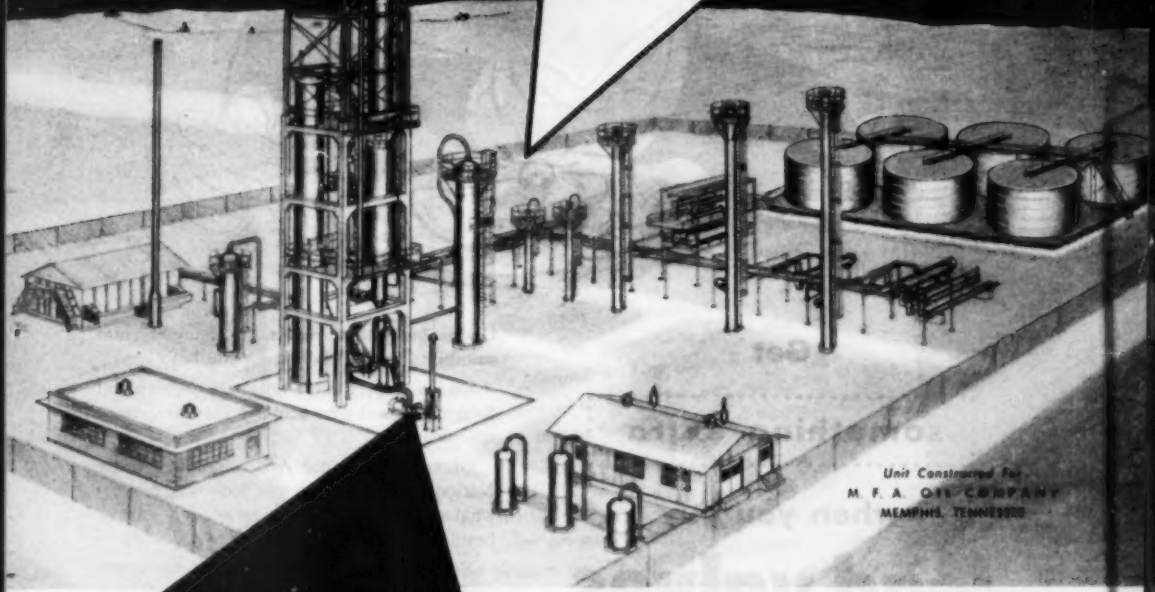

Vacuum Air-Lift Unit
d Constructed by Koch

This Soc... ...lytic Cracking Unit will give you an outstanding combination of low ... ..., minimum operating costs, and highest yields of premium quality gasoline and burner oils.

The capacity of this Socony Air-Lift Catalytic Cracking Unit ranges from 1,500 barrels per day of fresh gas oil feed at 90% conversion to 3,000 barrels per day of fresh gas oil feed at 50% conversion. Standard units are available also for greater capacities.

We will be glad to submit information on any refining process to fit your requirements. *Write us today, no obligation.*

Get

something extra

when you buy

lead valves

Do you look for sturdiness, dependability, and suitability in the lead valves you buy?

Do you expect valve type, size, pattern and flanging to meet your acid handling equipment specifications?

Of course you do! And when you order National you *get* what you look for. You *get* what you expect. And you get certain "extras" besides... extras that spell highest quality.

For example, the lead used is the grade acknowledged best for acid-handling—St. Joe Chemical Lead. Furthermore, National Lead valves have precision, lathe-turned stems. They have full flow-ways. They're designed to permit repacking in service. And they have positive plug-seat fit.

Fabrication extras ... design extras ... quality extras ... Yes! And these extras you get, but never need specify, add up to outstanding service on the job.

That's why it pays to buy National valves ... for something extra in lead.

New York 6; Atlanta; Baltimore 3; Buffalo 3; Chicago 8; Cincinnati 3; Cleveland 13; Dallas 2; Philadelphia 25; Pittsburgh 12; St. Louis 1; New England: National Lead Co. of Mass., Boston 6; Pacific Coast: Morris P. Kirk & Son, Inc., Los Angeles 23, Emeryville 8 (Calif.), Portland 10, Seattle 4; Canada: Canada Metal Co., Ltd., Toronto 8, Montreal, Winnipeg, Vancouver.

* Reg. U. S. Pat. Off.

Lead valves

with a NATIONAL reputation

LEAD COMPANY

TNEMEC PRIMERS KILL RUST!

SMALL amounts of moisture will inevitably penetrate any paint film, causing rust and corrosion . . . but TNEMEC *uses* this moisture to destroy rust at its source!

TNEMEC PIGMENT is a compound which includes and intensifies the preservative properties of Portland cement. Combined with moisture, it creates a neutral condition on steel surfaces, changing active rust and corrosive agents into an inactive neutral compound.

That's the amazingly simple process that makes TNEMEC so outstandingly successful as a prime coat on steel. We invite you to investigate the performance of TNEMEC Primers on any type of installation . . . for adhesion, waterproofness and durability . . . under the most severe conditions. Its record as a long-lasting, anti-corrosive coating is unique.

Ask Any TNEMEC User
(TEE-NEE-MIK)

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Gentlemen:
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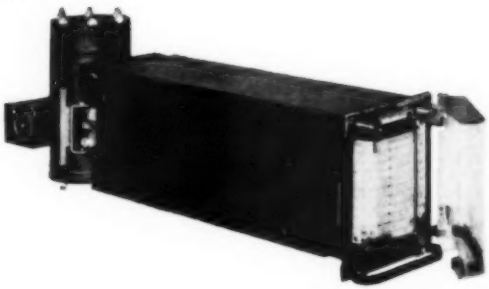
PLUG IN

THE NEW IDEA IN PANEL INSTRUMENTATION



Taylor, pioneer in the 3-part control system, brings many new refinements based on extensive field experience

1. Change from simplest to most complex control by simply unplugging one unit, plugging in another.

2. Change from indicator to recorder or vice versa in only 10 seconds.

3. One mounting for both controller and receiver — recorder or indicator.

4. Recorders or indicators can be mounted on the panel without welding, without drilling holes.

5. Only piping connections required are air supply, controller output, and to variable transmitter. All other connections made automatically in self-sealing manifold.

6. All adjustments can be reached without disturbing any connections.

7. Mountings are extremely simple and rugged.

8. You save panel space by mounting units a few inches apart.

9. Receiver mechanism totally enclosed by protective sleeve.

10. You save money on installation — thanks to simplified piping and mounting.

ADDITIONAL NEW FEATURES IN TAYLOR'S TRANSET® RECORDER:

Continuous valve position indication on separate scale tells valve pressure at a glance.

Chart read-back device gives easy access to past records without disturbing any function of the recorder or interrupting the record.

New chart drive mechanism for greater convenience and greater dependability.

Be sure to get information on the new and greater plug-in type Taylor TRANSET Control before you make any decision involving pneumatic transmission control. Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

PETROLEUM REFINER

The LOOK BOX

Your Chance To Brag

MOST PEOPLE employed in the oil business have a lot of pride in being connected with an industry which is so progressive, which still is exploring and conquering frontiers, both from a scientific and a geographic standpoint.

The oil business itself has been carrying on for the past few years a program of educating the public to know that the oil business is a serious business, not a game. The slogan on which this advertising campaign is based is one which carries a particularly warm appeal to those employed in the oil refining business and to closely allied activities. "Oil is Progressive" is the slogan. October 12 to 18 is "Oil Progress Week." One might as well say it is Oil Process Week, because processing has shown so much progress during the past few years.

But the other branches of the oil industry are progressive too. Ninety-six years ago when the first oilwell was drilled by Colonel Drake at Titusville, Pa., the original "oil men' really struggled to get down 69 feet! Now there are two wells, both in the U.S.A., which have drilled well below 20,000 feet—nearly 4 miles! And of course it took a lot of progress to be able to do that. Last year enough oilwell "hole" was drilled in the U.S.A. alone to run around the earth one and a half times at the equator. Quite a bit of progress even for the past 15 years!

But when we speak of oil as being progressive, just what do we mean? That the stockholders are progressive? that management is progressive? that the scientific men employed in research are progressive?

Yes—all of them plus those in the construction and operation departments, too—because the progress must be built in and operated before it really is progress.

So all of you in the processing field are a part of the picture.

Oil Progress Week, October 12 to 18, is a good time to tell your non-oil friends and neighbors about how progressive the oil industry really is—*you* have had a *part* in some of it. "Oil Progress Week" is your warrant and commission to do some old fashioned boasting about what your particular group has done, and if anybody intimates that you are bragging—just tell 'em Oil Progress Week has been officially set aside to get over the truth about the oil business and you are only doing your part!

No Idle Play On Words

AS PETROCHEMICAL production continues to double itself every five years, your editor was interested in looking back ten years to the time when PETROLEUM REFINER first put petrochemicals on its front cover. It was in August, 1942, that we changed the name of our magazine to its present title and added the by-line, "Specialized for the oil refining industry, including *petrochemical* engineering, petroleum synthetics and natural gasoline."

Though 1942 was the year that the term petrochemicals had just come into being, we think the editor's outlook was so sharp that we are quoting his words from the Look Box for that month:

" 'Petrochemical' is no idle play on words, for the petroleum refinery is now engaged in making raw chemicals for other industries, also making finished chemicals, which it may furnish to the public or leave for other distribution. It is no longer possible to restrict petroleum refining from chemical processing. Pressure of military requirements has brought this advancement ahead of any expected normal development.

"Now that it is here, the chemicals now being produced and known to be available in crude oil force this industry into wider applications of finished materials. Just as *Refiner and Natural Gasoline Manufacturer* maintained a viewpoint as wide as the advancement from straight distillation into chemical processing, PETROLEUM REFINER will hold a similar viewpoint in chemical processing, petroleum synthetics and in natural gasoline."

Spend Money to Make Money

INSTRUMENTATION provides the key to new ways to make money by spending money. Instruments do a better, more efficient, and more economical job of operating plants than can be done by even the most skilled manpower. An additional rich dividend is provided in that highly trained technicians can be released to the pursuit of new and finer processes. These points were highlighted in a recent address by Porter Hart, of the Dow Chemical Company, Texas Division, and president of the Instrument Society of America. The occasion was the exhibitors' luncheon held during the ISA convention at Cleveland, Ohio. Here are Mr. Hart's remarks:

"I want to state at the outset that I have attended all of the ISA conferences and exhibits, and as a user realize their importance to industry.

"In our processing plants we are constantly aware that instruments do most of the day-to-day seeing, feeling, and thinking in their operation. Previously this has been done by highly trained

For Lowered Gasoline Treating Costs

Select the Most Effective Du Pont Antioxidant

Gasolines vary in their response to different types of antioxidant. And different handling or storage methods may affect stability or response to antioxidant treatment. When natural inhibitors are present in the gasoline, induction period determinations are not always reliable indications of the tendency to form gum in storage. In some cases addition of small amounts of the proper antioxidant as the gasoline leaves the cracking unit may be desirable to prevent gum formation prior to Doctor sweetening or caustic washing. This often makes possible a considerable economy in the final treating.

To help you find the most economical solution to these gasoline stabilizing problems, Du Pont offers the following services:

1. Du Pont District Laboratories will help you evaluate your stock in terms of its antioxidant needs . . . and provide you with recommendations to fit your own refinery processing operation.

2. Du Pont helps you use these recommendations at the lowest possible cost by offering *two* Gasoline Antioxidants—No.'s 5 and 22. No. 5 is 50% N-normal-butyl-para-amino-phenol in 20% Anhydrous Methanol and 30% Anhydrous Isopropanol. No. 22 is N:N'-di-secondary butyl-para-phenylenediamine. Both are available from warehouses in Los Angeles, California; Houston, Texas; and Carney's Point, N. J.

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Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

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IN CANADA: Canadian Industries Limited—Toronto, Ont.—Montreal, Que.—Calgary, Alta.

engineers and technicians. The present day plants take advantage of these new methods and they are designed around instruments as a type of 'super-Vision' (with a capital 'V'). This 'super-Vision' has made it possible that once a new plant has been designed, built and put into operation on automatic control, it requires little attention from operating personnel, thus freeing brainpower for further engineering and development work.

Porter Hart

"Most chemical and petroleum processing companies will agree that they can afford to spend $100,000 on instruments to make a full-time man twice as productive. You instrument manufacturers have made this possible.

"I have spoken of instruments as a form of 'super-Vision' in the processing plants. They also perform the same duties for research and development groups as well as all types of manufacturing. Only with this increased productivity of the scientist, the engineer, and the worker can we maintain and improve our high standard of living.

"Because instruments are educated to see, feel, taste, smell, and hear operating factors, they act as supervisors, doing the thinking and making adjustments for general operations. I offer a toast to your contribution to 'super-Vision,' with a capital V."

Far-sighted leaders in the refining and petrochemicals fields heartily endorse the sentiments expressed by Mr. Hart. PETROLEUM REFINER editors have long been cognizant of the increasing importance of instrumentation to their readers. With this in mind, a most important contribution is being prepared in the form of a special Instrumentation issue, scheduled for December. The details are a secret right now, but watch next month's Look Box for a special announcement!

Stocks in Favorable Position

THERE HARDLY needs to be any concern over adequate supply of heating oil this winter, no matter how severe the weather may be. Despite the refinery strike, the nation's refiners have done an excellent job of overcoming the production loss and assuring its customers of sufficient fuel. This favorable stocks position has been the result of record-breaking operation of the industry's plants and proper adjustment of output yields.

Since the strike's end, distillate fuel and gasoline have been made in record quantities, while the heavier residual oils have been held to year-ago yields. This has vastly improved the distillate and motor fuel stocks position and prevented accumulation of excessive amounts of residual.

Heating oil stocks are on the road to their highest level in history. With 112½ million barrels of distillate fuel in storage by mid-September, it is certain that more than 120 million barrels will be tanked by the first of November. That would compare with 109½ million barrels on hand a year earlier.

Inventories of the light heating oils are now slightly more than 10 million barrels greater than at the same time in 1951. The remarkable recovery made since the strike is evidenced by the fact that at the end of June distillate stocks were 7 million barrels below inventories of a year earlier, and since that time about 46½ million barrels have been added to supplies. As a result the industry can enter the winter consuming season with the largest heating oil supply in history.

Stocks will continue to gain, and certainly should prove adequate to satisfy the larger consumption rates expected this winter. It will take unusually cold weather to cause oil shortages this season.

Other refined product stocks are in fairly good position. Gasoline inventories were about 4¾ million barrels under 1951 levels, but at the current rate of plant operation they are gaining rapidly and have plenty of time to catch up during the coming low-consumption season. Residual oils are a little larger than they were a year ago, but continued reduction of yields of this product can prevent excessive accumulation.

Widespread Corps on Job

DURING THE past month, hundreds and hundreds of new subscriptions to PETROLEUM REFINER have rolled into our Houston office. Men engaged in every important phase of the industry—and from almost every section of the country—have requested that their subscriptions start with last month's Process Issue.

And all of this is the result of the fine job you, our readers, did as "Temporary Circulation Managers." Bob de Sombre, our full-time Circulation Manager, has asked us to pass along his thanks to all of you who accepted the appointment. The response has been overwhelming . . . and heartwarming. We can't help but feel that the wonderful cooperation you have given us has something to do with the value you yourself place on PETROLEUM REFINER. And we plan to make every effort to see that we continue to merit your confidence.

Only a limited number of copies of the big Process Issue are left. So if any of your fellow workers haven't as yet sent in their orders, please tell them to write us as soon as possible. And—once again—many thanks for your cooperation.

NOW AVAILABLE!

SWISS INVENTA PROCESS FOR

UREA

VULCAN CINCINNATI

PROCESS

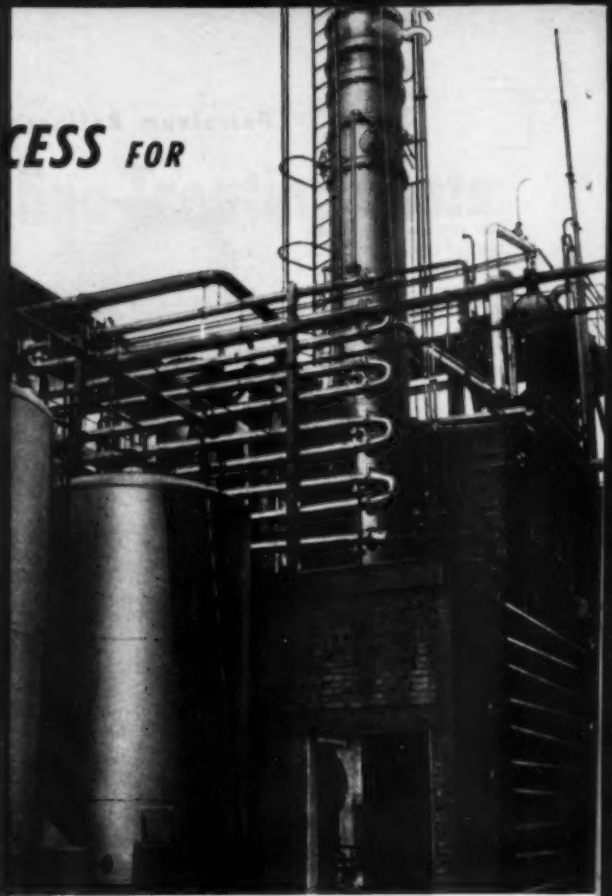
- Commercially proven
- Highly efficient
- Complete recycle of unused materials
- Substantially eliminates corrosion problems

PRODUCTS

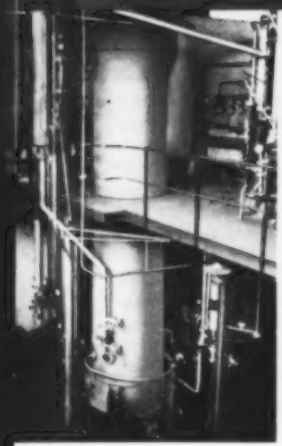
- Crystalline or high grade solution urea
- Urea Phosphate and Cattle Feed
- Pellets for fertilizer

RAW MATERIALS

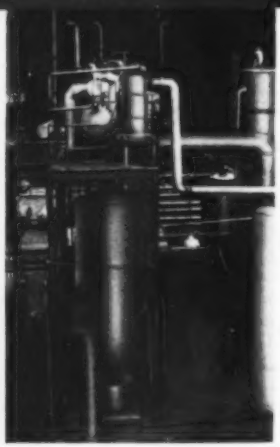
- Ammonia and Carbon Dioxide from natural gas or other sources



Commercial scale manufacture of Urea by the Swiss Inventa Process has been carried on in this plant at Ems, Switzerland, since early 1949.



UREA SYNTHESIS



RECYCLE SECTION

The Inventa Process has been fully translated to American design and economic requirements and is offered by Vulcan Engineering Divison in the United States and Canada. Vulcan is equipped to design and construct complete Urea plants and will give prompt attention to inquiries concerning the commercially proven Inventa Process.

VULCAN
CINCINNATI

VULCAN ENGINEERING DIVISION

The Vulcan Copper & Supply Co.
General Offices and Plant, CINCINNATI 2, OHIO

NEW YORK BOSTON PHILADELPHIA SAN FRANCISCO
VICKERS VULCAN PROCESS ENGINEERING CO., LTD., MONTREAL, CANADA

OTHER DIVISIONS OF THE VULCAN COPPER & SUPPLY CO.:
MANUFACTURING DIVISION • CONSTRUCTION DIVISION • INDUSTRIAL SUPPLY DIVISION

Industry Accepts Vocational Guidance Responsibility

A number of devices are available to industry to help do a better job of fitting the worker to his task

Eugene J. Benge
Benge Associates
Asheville, N. C.

AMERICAN industry hires employes, or switches them from job to job with a carelessness it dare not exercise with basic materials like oil, wood, chemicals or metals. We tend to think of men quantitatively not qualitatively. We say: is he strong enough? smart enough? skilled enough? To these we should (but we don't) add: Does he manifest traits of persuasiveness? dominance? emotional maturity? Does he derive satisfaction from working with people? ideas? words? mathematics? physical objects? routine matters? creative problems? Does he have ambition? perserverance? integrity?

So we assign potential salesmen to machine tending jobs; potential supervisors to research; potential researchers to selling. The stark fact is that each hiring, transfer or promotion is actually *vocational guidance.*

The principal devices industry has available to help it do a better job of fitting workers to jobs include:

- Aptitude tests
- Physical examinations
- Job analysis
- Merit rating

Underlying are large social implications, as industry uses these new tools to discharge an old responsibility. Employes generally have sought relief from their work life frustrations by demanding wage increases and legislative actions. Better job adjustment of employees reduces their frustrations, and therefore their pressures for economic and legislative change, furthermore increases productivity per man. If for no other reason then enlightened self-interest, employers should delve into the profit possibilities of better employe adjustment.

Following World War I, extensive research showed conclusively that the intelligence and trade tests given to several million soldiers provided differentiations of great significance to civilian and industrial life. In the period between World War I and World War II, psychologists worked out many frutiful applications of testing in the field of industry. Various tests of dexterity and of coordination were successfully used by many companies for different types of manual operation. Some companies found that tests of trade information enabled them to differentiate beginners from experts among applicants.

Most of the paper tests and dexterity tests can be administered by a personnel assistant, who merely refers the score to a table in order to determine the grade of an applicant, and needs no training in psychology.

Workers in the field early came to realize that there were factors at work in achieving success other than ability. These factors dealt with interests and with personality development.

Personality Tests

Most of the so-called personality tests are too time consuming and too difficult of interpretation to be of immediate use in personnel departments. In the long run, however, they may have great significance. Here are two research chemists—one brilliant, one mediocre. Your company is ready to fire the mediocre man; but the tests reveal that he would make an excellent production foreman. Your company considers promoting the brilliant chemist to a plant superintendency; the tests predict that he would be incapable of accepting responsibility, would be bewildered by administrative detail. Better for him and for the company to leave him in his present research capacity. So the tests for executive ability will conserve the experience of both men. The company will have given a high-level vocational guidance.

Thousands of companies are using aptitude tests in selection, transfer, promotion. Of 522 companies returning a questionnaire sent out by the National Industrial Conference Board, 49 percent had instituted testing programs between 1941 and 1945.

In this period, too, industry extended the use of physical examinations, both for applicants and for periodic re-examination of employes. Tests of leg and back muscles in lifting, of hand grip, of lung capacity and of endurance were found helpful in selecting manual workers.

Visual testing in industry has been subjected to a great deal of research. The simple eye chart, placed at 20 feet, has given way to apparatus designed to test different aspects of vision, such as depth perception, lateral imbalance, vertical imbalance, astigmatism, color discrimination and combined vision from both eyes. Some companies have found that tri-focal glasses help workers whose jobs force them to work at varying visual distances. In accepting responsibility for measuring eyesight or improving working conditions to aid eyesight, industry is making a distinct contribution to social welfare as well as to productivity.

Testing of hearing, still in its infancy in industry, will likely become as much a part of the entrance physical examination as is vision testing today.

It was inevitable that test researchers should attempt to use results from job analyses.

Several methods were developed for analyzing jobs in terms of factors which were measurable by tests. This simple idea represented a great stride forward. Thus a job analysis might show that the work required knowledge of fractions and decimals, a wide vocabulary, a knowledge of technical matters in a given field, speed and accuracy in clerical matters, interest in working with mathematics and in persuading other people. These terms then suggested the specific kinds of tests needed in contra-distinction to the generalized tests used heretofore.

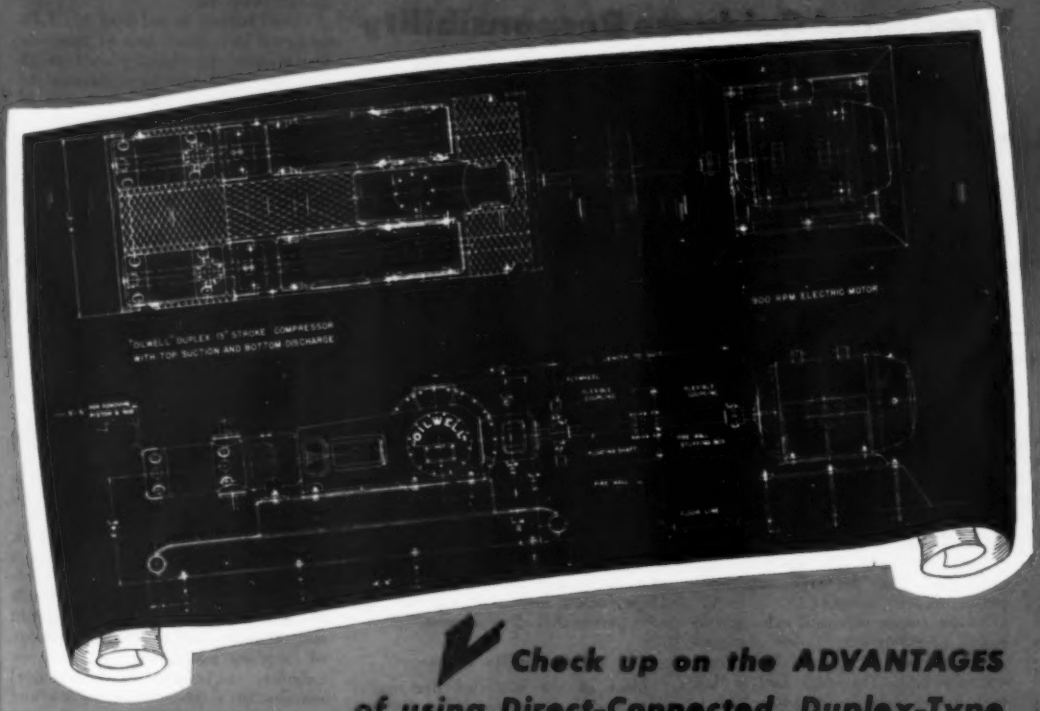
It became possible to draw up profiles of job and man, to match one with the other in order to judge whether a particular applicant had the attributes likely to succeed and to note the areas in which he seemed to be deficient so that training could be given. In a sense this double profile method provided the marriage between job analysis and aptitude testing. It is the distinctly new step forward in the field of aptitude testing, one which promises to prove revolutionary.

Most formal merit rating plans have been developed for purposes of wage and salary administration. Too frequently they call for ratings on such glittering generalities as dependability, versatility, potentiality or other ilities and alities. A more specific plan can be more useful, as follows:

1) List what the employe *on his present job,* must know, do and be. Be specific.
2) Rate each item listed depending on how adequately the employe

(See GUIDANCE, Page 71)

SINGLE or MULTIPLE Units!



Check up on the ADVANTAGES of using Direct-Connected, Duplex-Type

"Oilwell" Compressor Units

. . . for Gas Compression in Refineries

"OILWELL" UNITS of this type are slow speed; designed with direct drive through right-angle gears to two parallel compressors so as to utilize 300 hp. input from a single prime mover with maximum efficiency.

For applications in the larger-volume-low-pressure range, single-stage compressors can be furnished. Where higher pressures are required, multi-stage compressors can be furnished to develop discharge pressures to 3,000 p.s.i.

Installations in hazardous areas can be made with maximum safety, by incorporating a fire wall between unit and driver as indicated in the sketch.

Where gas concentrating operations exceed the capacity of a single compressor unit, multi-unit installations are highly practical because they permit the routine servicing of individual compressors when necessary without shutting down the entire operation.

Let your "Oilwell" Representative . . . quote on "Oilwell" Compressor Units to meet the gas-concentrating requirements of your refinery.

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UNITED STATES STEEL

Who's Building What?

Contract for Phenol Plant Awarded to Stone and Webster

Standard Oil Company has awarded a contract for construction of a phenol plant at Richmond, Calif. to the Stone and Webster Corporation. To be the first phenol plant in the west, it will cost approximately $4 million. Actual construction is scheduled to begin early next year and the plant is expected to be completed about the end of 1953.

The installation will utilize a recently-developed synthesis process in which neither sulfuric acid nor chlorine is used.

Dutch Catalyst Being Built

The Dutch Koninklijke Zwavelzuurfabrieken Voorheen Ketjen of Amsterdam is building a 7½ million guilder plant on its Amsterdam site for the production of petroleum catalyst. The catalyst will be produced under license from the Cyanamid Company of New York. The new plant is expected to go into operation next year.

$17.5 Million Plant Planned By Grace

W. R. Grace & Company has made plans to build a new $17.5 million plant using natural gas as raw material to manufacture ammonia and urea. A 30-year, $35 million loan, half of which will be used to construct the plant, has been obtained by the company from four major insurance companies. The location of the plant has not yet been made known.

Guidance

• CONTINUED FROM PAGE 69

meets it, as shown in Chart A.

CHART A

Rating	Degree	Rating	Degree
6	Outstanding	2	Below average
5	Very High	1	Very Low
4	Above Average	0	Deficient
3	Average or usual		

3) Analyze each listing for ratings of 2, 1 or 0. These job requirements are not matched by employe qualifications, and suggest maladjustment to the task or need for training.

Merit rating, in conjunction with the other devices outlined in this article can indicate with considerable certainty whether an employe is well placed, i. e., whether the employer has properly discharged his vocational guidance responsibility.

Rate of Petroleum Expansion Applications Has Fallen Off

The Defense Production Administration has reported a definite slowing in the rate of applications for petroleum project expansions. The agency said that it was not sure whether this was merely a seasonal lull or whether some phases of the expansion program might be in danger of falling short of their goals. It was also pointed out that a number of expansion goals have already been reached.

Nine projects, with name of the company, location of the facility, amount certified and percent approved for rapid write-off during the period from mid-August to mid-September were:

Sunset Oil Company—Los Angeles, petroleum refining facilities, $76,900, 40 percent and $2.2 million, 25 percent.

Mid-West Refineries, Inc.—Alma, Mich., gasoline facilities, $348,000, 65 percent.

Standard Oil Company (Indiana) — Wood River, Ill., petroleum refining facilities, $425,000, 25 percent.

Natural Gasoline Corporation—Hawkins, Texas, gasoline facilities, $325,000, 65 percent.

Tide Water Associated Oil Company —East Bernard, Texas, natural gasoline facilities, $646,574, 65 percent.

Cities Service Oil Company—Terrebonne Parish, La., natural gasoline facilities, $2.8 million, 65 percent.

Texas Gas Products Corporation—Upton, Midland, Regan and Glasscock Counties, Texas, natural gasoline facilities, $2.7 million, 65 percent; $190,000, 90 percent.

McMurrey Refining Company—Tyler, Texas, petroleum refining facilities, $70,000, 50 percent.

Malco Refineries—Prewitt, N. Mex., petroleum refining facilities, $239,500, 65 percent.

Phillips Petroleum Company — Phillips, Texas, cyclohexene concentrate facilities, $145,900, 50 percent; $731,000, 65 percent.

$28.5 Million Refinery Built by Shell in Provence

The Shell Oil Company has constructed a new refinery in Provence, France which is large and versatile enough to make France self-sufficient in carburants and liquefied gas. It is the first refinery in Europe capable of supplying all the basic needs in these fuels to the nation. The refinery, at Berre-L'Etang, cost $28.8 million and has a capacity of three million tons a year.

Cities Service to Maintain Petty's Island Grease Unit

The Cities Service Oil Company said recently that it will continue to operate compounding and grease making facilities at its Petty's Island plant, near Philadelphia. The oil refining equipment at Petty's Island, which had 12,000 barrels a day capacity, is being dismantled under a contract awarded to J. S. Berkwit & Company. The facilities have been idle more than five years.

Bureau Retort Completed

Construction has been completed on the Bureau of Mines' demonstration-scale retort at Rifle, Colo. The unit shown above employing a relatively new and promising process for continuous extraction of oil from oil shale, was built by the Blaw-Knox Construction Company of Pittsburgh and is patterned after a six-ton-a-day pilot plant that has proved the "gas combustion" process the most efficient and most economical ever developed at Rifle.

Major objectives of the new retorting plant, which has a capacity range from 150 to 400 tons of oil shale daily, are 1) to determine cost and yield data that will permit an accurate evaluation of "gas-combustion" process; 2) to provide the technical information that industry will need to design commercial plants; and 3) to supply crude shale oil in quantities required for the Bureau's refining studies.

The Catalytic Construction Company of Philadelphia has been awarded a contract to design a catalytic refining demonstration plant for the same project. The proposed unit will be used to demonstrate the refining of shale-oil distillates by catalytic means in reforming and treating processes.

Catalytic Construction will furnish engineering and design services for the plant following processes developed by the Oil Shale Demonstration Branch of the Bureau of Mines.

New Unit Enables Balikpapan To Raise Crude Production

The third distillation unit of the B.P.M. Balikpapan, Indonesia refinery, which recently entered into operation, will enable the production of crude oil in the refinery to be raised to more than 42,000 barrels a day. Crude oil production in Balikpapan has declined some 50 percent since before the war, now averaging some 490,000 barrels.

Standard-Vacuum to Build $35 Million Bombay Refinery

The construction contract for Standard-Vacuum Oil Company's new 25,000-barrel-a-day oil refinery in Bombay has been awarded to the Lummus Company. Engineers are now in Bombay to complete survey work for construction of the $35 million project.

Altona Refinery Expansion

Standard-Vacuum Oil Company has announced plans for the expansion of its Altona Refinery near Melbourne, Australia, calling for an 11-fold increase in capacity.

The additional facilities will help meet the new demand for oil caused by Aus-

tralia doubling its prewar consumption, the announcement said.

When completed in 1955, the expanded refinery will have a capacity of 22,000 barrels a day. It will represent an additional investment of $30 million.

Albanian Refinery to Begin Operating Soon in Valona

The Albanian government will soon place into operation a petroleum refinery which it is building at Valona, Albania. According to the report received by PETROLEUM REFINER, the plant will be built with equipment imported from Russia, for the purpose of eliminating the necessity of having the Albania crude oil in Russian refineries as it has been in the past. Because Albanian crude oil output has decreased approximately 50 percent during the first six months of 1952, the country will still import refined products from the East. This shortage has prompted the government to construct a coasting station with a capacity of 470,000 barrels, in addition to the storage facilities already existing there.

Rotterdam Refinery to Get 50 Percent Capacity Boost

The capacity of the Bataafsche Petroleum Company's Pernis, Holland, refinery is to be expanded to about 180,000 barrels per day from about 120,000 barrels daily. A fourth distilling unit now under construction will have a daily capacity of 73,000 barrels daily. Plans are also being formulated to enlarge Bataafsche's chemical, asphalt, and lubricating oil branches.

Britain's New Oil Refinery Set for Early Completion

The new oil refinery being built at Coryton on the Thames 25 miles east of London will probably begin distilling crude oil almost a year ahead of schedule, according to reports from Britain.

Owned by the Vacuum Oil Company Limited, the refinery is being financed equally by the British Powell Duffryn group and the American Socony-Vacuum Organization. A $34 million project, it is expected to process about 850,000 tons of crude oil annually.

AIOC Hikes Output At Llandarcy Refinery

The Anglo-Iranian Oil Company has announced that its refinery at Llandarcy near Swansea has increased its throughput to four million tons annually through large scale developments. One of the major developments was in production of motor spirit. The present output of 500,000 gallons a day will be increased by 50 percent when further developments come into operation.

New $112 Million Refinery To Be Built Near Nairobi

Oil companies operating in East Africa are planning to build a large oil refinery near Nairobi, Africa. The refinery will cost about $112 million and will be located on a 2200-acre site on the south mainland opposite Mombasa Island.

Jefferson Expanding Laboratory Space

Jefferson Chemical Company, Inc., has started construction on a half-million-dollar addition to its research laboratory facilities at Austin, Texas. The larger of the new buildings will ultimately provide bench-scale research facilities for about 50 chemists. The smaller building will add to present office and library space. The company said its decision to increase the scale of research activities was based in part on its successful introduction of several new chemicals developed in the present laboratories during the past year.

West German Refiners Trail In Capacity; Pickup Planned

At the annual conference of the Liquid Fuel Merchants Association held recently in Germany, it was reported that Western Germany's crude oil refining capacity is currently about seven million tons annually, but is not fully exploited.

While refining in the current year is expected to amount to 5.5 million tons of crude oil, about 1.6 million tons will be of German origin. About five million tons of liquid fuel will result. A further 500,000 tons will have to be imported to cover West German fuel needs. At the meeting, it was predicted that liquid fuel production in 1953 will exceed consumption.

Indiana Standard Raises Sights For Mandan Plant

Standard Oil Company (Indiana) has revealed that the initial capacity of its planned refinery at Mandan, N. D., has been revised upward from 15,000 to 30,000 barrels a day.

The Petroleum Administration for Defense recently approved the plant for accelerated amortization of investment and allocated 6728 tons of steel to it. About $60 million will be used for working capital and for construction of the new facilities. These will include the Mandan installation and a products pipe line to connect the new refinery with the company's northwest pipe line in the Fargo, N. D.-Moorhead, Minn. area.

Plans Completed for Phillips Gasoline Plant

Phillips Petroleum Company has completed plans for its Pembrook natural gasoline plant in Spraberry Trend, West Texas. The plant will be 20 miles from the company's Spraberry plant, now under construction. It will have a daily capacity of 60,000,000 cf. and is expected to begin operating in the early part of 1953.

Multi-Million Dollar Plant Planned by Amerada Petroleum

Amerada Petroleum Corporation has announced plans for the construction of a new natural gas plant in the Williston Basin of North Dakota to reclaim the natural gas produced from its oil wells in that area. The new plant will cost between $10 million and $20 million.

Propane Deresining Unit To Be Added by Sinclair

Sinclair Refining Company will soon begin construction of a new propane deresining plant at its refinery in Wellsville, N. Y. The design capacity of the unit is 700 barrels a day of Pennsylvania 600 flash steam refined stock.

For the past three months, operations have been under way to clear the property and to prepare the site for the new construction, which is expected to be completed and in operation next Spring.

The Fluor Corporation of Los Angeles will construct the new $1 million unit.

New Saskatchewan Refinery Opened by British American

The British American Oil Company Limited recently announced the official opening of the company's enlarged and modernized refinery at Moose Jaw, Saskatchewan. Premier T. C. Douglas of Saskatchewan was the chief speaker at the opening ceremony.

The new refinery, which incorporates the province's first catalytic cracking unit, is expected to have a capacity of 15,000 barrels a day. The plant took 22 months to complete and gives employment to approximately 180 men and women.

Two New Units Scheduled For Humble's Baytown Plant

Plans for construction of a catalytic light ends unit No. 2 at its Baytown, Texas, refinery sometime in 1953 have been made by Humble Oil and Refining Company.

Construction of an effluent filtration unit has recently been completed and work on a paraxylene crystallization unit is scheduled to begin in December. Completion of this unit is expected to be in May of 1953.

Natural Gasoline Increases Capacity of Texas Refinery

Construction was recently begun on additions of new plant equipment to the Natural Gasoline Company's plant at Hawkins, Texas. It will increase capacity of the refinery, which now has a daily capacity of 18 Mmcf, to 21 Mmcf of natural gas daily.

The work is expected to take six weeks. The Gasoline Plant Construction Company, Houston, has the contract.

• More Construction, Page 74

FROM OUR FILE OF HEAT INSULATION JOBS

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Pipe lines carrying steam, air, hot and cold water

KEY TO PIPE LINES:

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The neat finished appearance of this maze of nested fittings and close-together pipe runs didn't just happen. It resulted from sound engineering and top-grade workmanship. First, piping was laid out carefully with lines spaced to allow for full insulation thickness at all points. Second, the insulation was applied and finished in a workmanlike manner by the mechanics of Armstrong's contracting organization.

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Ontario's Newest Refinery Now Operating in Sarnia

Canadian Oil Companies, Ltd. recently celebrated its fiftieth anniversary as a refiner with the dedication of its new 20,000-barrel-a-day refinery at Sarnia, Ont. The $23 million project, the largest part of the company's $27 million construction program, has been in full operation for several months following a unit-by-unit start-up that commenced earlier this year.

Constructed with the approval of the Canadian Government as a national defense plant with defense-rated steel allocation from both the Canadian and U. S. governments, the new plant is connected by pipe line to the government's Polymer Corporation to supply butylenes to the British Commonwealth's only synthetic rubber establishment. The plant also has a pipe line connection to the nearby Dow Chemical of Canada plant for supplying the latter with raw materials.

Stone & Webster Engineering Corporation handled the design and construction of nearly all of the general services.

Atlantic Refining Announces Use of New Catalytic Process

The Atlantic Refining Company recently announced that the first commercial plant using Atlantic's new catlytic reforming process has been put into operation at the oil refinery of the McBride Refining Company, Lablanca, Texas. The unit has a capacity of 750 barrels a day.

A second unit using the Atlantic process is under construction by Malco Refineries, Inc., at Prewitt, N. Mex. Atlantic is building an 11,000-barrel-a-day plant at its Philadelphia refinery and is designing another large unit to be constructed at its refinery at Port Arthur, Texas.

Chapman Reports To Congress, Urges Synthetic Production

Interior Secretary Chapman, in his annual report to Congress on synthetic liquid fuels, recently urged industry to establish commercial plants for producing oil from shale and coal.

The report is particularly optimistic regarding oil shale, claiming that return from such an investment would be high enough to warrant "serious attention."

Regarding coal hydrogenation, the report said something in the way of government incentives to private industry may be required at this time. No details were given on how or in what manner these government incentives might be provided.

Chapman stressed the national importance of developing new sources of liquid fuels, saying "there is little question but that some time in the future domestic crude oil will have to be suplemented with liquid fuels from both coal and oil shale. The job will not be done with either alone."

Free-World Refiners Surpassing U. S. Hopes

Deputy Petroleum Administrator J. Ed Warren reported, at the end of 1952, refining capacity in those nations outside the iron curtain may reach about 5.8 million barrels of crude oil a day.

At the end of 1951, the capacity was 5 million barrels a day. The U. S. thought an expansion of about 768,000 barrels a day was feasible in two years, viz., 1952 and 1953.

During the three years, 1949, 1950, and 1951, foreign demand increased at a rate of about 460,000 barrels a day each year, while U. S. demand went up at a rate of 240,000 barrels a day.

Catalytic Cracking Unit Planned by Antwerp Refinery

A Houdriflow catalytic cracking unit will be installed at the Antwerp refinery of Albatros S. A. Belge pour le Raffinage de Petrole. The moving-bed installation, employing a gas-lift for catalyst circulation, is designed for a nominal capacity of 3600 barrels a day.

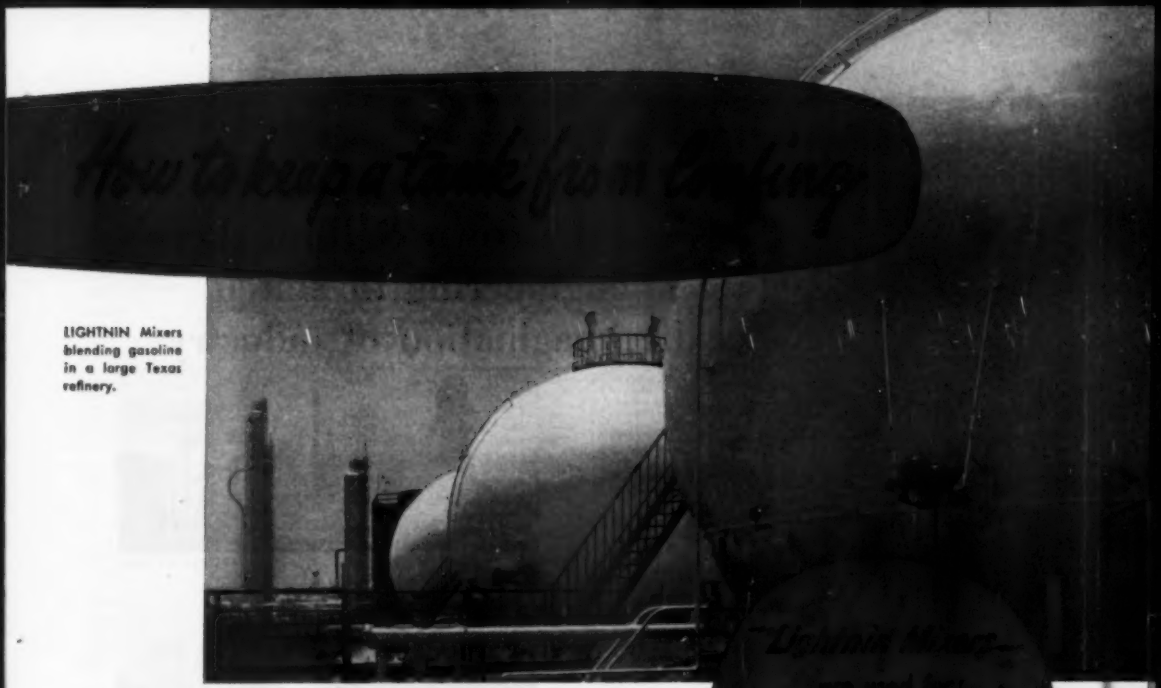
Sulfur Plant in Canada

Canada's first sulfur-from-petroleum plant is now operating at Jumping Pound, Alberta. The initial annual output will be over 10,000 tons, and the cost of the new plant is nearly $400,000. The sulfur is extracted from hydrogen sulphide in the natural gas treated at the adjoining Shell plant.

Refinery and Other Plant Construction

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
Allied Chemical	Hopewell, Va.	Syn. Nitrogen	150,000 tons yr.	$12.5 million					
Allied Chem. & Dye	N. Claymont, Del.	Chem. plt.		$3.5 million	Under Constr	1952			
Allied Chem. & Dye	Buffalo, N.Y.	Aromatics Fac.		$6,940,000	PAD Certified				
Ashland O&R	Catlettsburg, Ky.	Refinery Exp.	15,000 bbls.		Completed		Houdry	Ashland & Catalytic	Catalytic
Ashland O&R	Louisville, Ky.	Gasoline Exp.		$2 million	Certified DPA				
Ashland O&R	Buffalo, N.Y.	Expansion		$3.5 million	Under Constr.	1953	UOP	Catalytic	Catalytic
Ashland O&R	Tonawanda, N.Y.	Revamp Fac.			Under Constr.	End, 1952		Catalytic	Catalytic
Atlantic Refining Co.	Philadelphia, Pa.	Detergent Mfg.		$1.5 million	Under Constr.			Atlantic	Ferguson
Atlantic Refining Co	Philadelphia, Pa.	Cat. Reform.	11,000 bbls.	$4 million	Under Constr.	Early 1953	Atlantic	Badger Div.	Badger Div
Atlantic Refining	Philadelphia, Pa.	Two stage pipe still, Cat; Alky; Poly Units	50,000 bbl.	$5.6 million	Under Constr.	1953			Badger Div.
Atlantic Refining	Philadelphia, Pa.	Orthoflow Cat. Cracking	45,000 bbls.		Spring Constr.	1953		Kellogg	Kellogg
Atlantic Refining	Philadelphia, Pa.	Syn. Ammonia Plt.	100 tons		Under Constr.	Mid. 1953	Hydrocarbon	Hydrocarbon	Hydrocarbon
*Bureau of Mines	Morgantown, W. Va.	Synthetic Fuels Experiment Sta.		$2.6 million	Under Constr.				Southeastern Constr. Co.
California Refining	Barber, N. J.	Expansion	47,000 bbls.		Under Constr.	1952			
*California Refining Company	Barber, N.J.	Cat. Poly.	675 bbls.		Under Constr.	1953	California Research Corp.	Hydrocarbon	Hydrocarbon
Cambridge Gas Light Co.	Cambridge, Mass	Light Oil Recov	24 mmcf		Contracted			Blaw-Knox	Blaw-Knox
Coastal Oil	Pt. Newark, N.J	Storage Fac.		$275,000	PAD Certified				
Davison Chemical	Baltimore, Md.	Catalyst Mfg.		$210,494	Certified DPA				
Delta Refining	Memphis, Tenn.	Airlift Cat. Crk	3,000 bbls.	$1.8 million	Under Constr.	Late 1952	Socony Vac.	Koch	Koch
Delta Refining	Memphis, Tenn.	Cat. Poly.; gas cone; crude distillation revamp	12,000 bbls.		Under Constr.	Late 1952		Koch	Koch
Dewey & Almy Chemical Co.	Cambridge, Mass.	Synthetic Rubber Addition		$404,000					
Du Pont	Deepwater Point, N. J.	Tetraethyl Lead Fac.	140,000 lbs.	$3.4 million	Under Constr.	1952			
Elk Refinery Co	Falling Rock, W. Va.	Platformer	1,500 bbls.	$930,000	Completed		UOP	Procon	Procon
Esso Standard	Bayonne, N. J.	Crude Dist. Atmos Pipe Still	20,000 bbls. 28,500 bbls.		Under Constr.	Late 1952		Lummus, SOD & Foster Wheeler	Lummus, SOD & Foster Wheeler
Esso Standard	Everett, Mass.	Expan. Gaso.			Under Constr.	1953		SOD	Foster Wheeler
Esso	Everett, Mass.	Fluid Cat. Crk	18,500 bbl.		Under Constr.	Early 1953		SOD	
Esso	Everett, Mass.	Rerun pipe still	17,000 bbl.		Completed				
Ethyl	Edgemor, Del.	Tetraethyl Lead		$164 125	PAD Certified				
Frontier Oil Refining	Tonawanda, N.Y.	Refinery Exp.	15,000 bbls.	$6 million	Announced				
Frontier Oil Ref	Erie City, N. Y.	Base Ref. & Alkylation		$1.1 million	PAD Certified				
Geon (Goodrich)	Calvert City, Ky.	Petro chem. Plt.			Under Constr.	Late 1953			

* Continued on page 77



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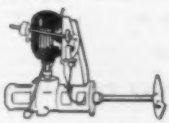

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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Gulf	Philadelphia	Crude; Atoms. & Vacuum Unit	125,000 bbls.		Under Constr.	Summer 1953		Foster Wheeler	Foster Wheeler
Gulf	Philadelphia	Gasoline Sweet.	40,000 bbls.		Designing	Summer 1953		Gulf	
Gulf	Philadelphia	Cat. Reform.	10,000 bbls.		Designing	Summer 1953			
Gulf	Philadelphia	Cat. Cracker	63,000 bbls.		Designing	Summer 1953		Kellogg	Kellogg
Hercules Powder	Gibbstown, N. J.	Petrochemicals		$6 million	Start Late 1952	1953			
Koppers	Kobuta, Pa.	Styrene Monomer		$4 million	Completed			Koppers	Koppers
Mathieson Hydrocarbon Chemical	Brandenburg, Ky.	Chemical Plt.		$17 million	Under Constr.			Badger Div.	Badger Div.
M. F. A. Oil	Memphis, Tenn.	Cat. Crk. & Aux.	2,200 bbl.	$1.7 million	Under Constr.	Dec., 1952	So-Vac	Koch	Koch
Monsanto	Charleston, W. Va.	Enlarg. Chem. Facilities		$9 million	Completed				
Monsanto	Springfield, Mass.	Polyvinyl chloride resin		$1.2 million	Announced				
Sinclair Ref.	Marcus Hook.	Sulfur Ext.	20 tons	$320,000	Completed			Parsons	Parsons
*Sinclair Refining	Wellsville, N.Y.	Propane Deres.	6700 bbls.	$1 million	Engineering	March, 1953		Fluor	Fluor
Socony-Vacuum	Paulsboro, N.J.	Expansion	46,000 bbl.	$12-15 million	Competed			Staff-Braun	Braun
Socony Vacuum	Paulsboro, N.J.	TCC Unit	15,000 bbls.		Completed			Staff-Fluor	Fluor
Socony-Vacuum	Paulsboro, N.J.	Products Exp.			Announced				
Socony-Vacuum	Paulsboro, N.J.	Bead Catalyst		$2.3 million	Under Constr.	Late 1952		Bechtel	Bechtel
Sun Oil	Marcus Hook,	Lube Oil Plt.	8,400 bbls.	$2.5 million	Completed			Sun	Sun
Sun Oil	Marcus Hook, Pa.	Airmorber and Houdriformer	10,000 bbls.	$8.4 million	Engineering	Fall 1952	Sun-Houdry	Texas	Sun
Sun Oil Company	Marcus Hook.	Aromatics Plt.		$12 million	Design			Kuljian	
Texas Company	Westville, N.J.	Crude Demalt.	60,000 bbls.		Under Constr.	Early, 1953		Texas Co.	
*United Fuel Gas Co.	Coco, W. Va.	Addition to Comp. Sta. & Dehydration	200 MMcf		Engineering	4 th Qtr., 1952		Fluor	Fluor
*United Fuel Gas Co.	Hurricane, W. Va.	Comp. Sta.			Under Constr.	4th Qtr. 1952		Fluor	Fluor
United Refining Co.	Warren, Pa.	Lab.			Under Constr.				
U. S. Industrial Chemical	Baltimore, Md.	Ethyl Alcohol Plt.		$328,815	Announced				
MID-CONTINENT									
Allied Chemical & Dye Corp.	South Point, O.	Synthetic Nitrogen	50,000 tons yr.	$12.5 million	Design				
*Amerada Pet. Corp.	Williston Basin, N. D.	Natural Gasoline Plt.		$10 million	Planning				
*Arkansas Fuel Oil Co.	Magnolia, Ark.	Increase Propane Recov.	100 MMCF		Under Constr.	Late 1952		Staff	
Ashland O&R	Catlettsburg, Ky.	Vacuum Unit	$11,000 bbls.		Field Work			Catalytic	Catalytic
		Crude Tower Unit	17,000 bbls.		Field Work			Catalytic	Catalytic
Ashland O&R	Findlay, Ohio	Gasoline Mfg.		$2.6 million	Under Constr.	Fall, 1952			
Aurora Gasoline	Detroit, Mich.	Basic Refining		$400,000	Announced				
Ben Franklin Rfg.	Ardmore, Okla.	Expansion	14,500 bbls.	$2 million	Under Constr.	1953	U.O.P.	U.O.P.	
Bureau of Mines	Otis, Kans.	Reopen Heli. Plt	48 Mcf/yr.	*$3 million	Under Constr.				
*Central Petroleum Co.	Coyle, Okla.	Gasoline Plt.			Authorized				
Cities Service Oil Co.	Chicago, Ill.	Grease-Making	8.5 million lbs.		Planned				
Cities Service	E. Chicago, Ind.	Fluid Hydroformer	10,000 bbls.		Design	Late, 1952		Kellogg	Kellogg
Cities Service	Blackwell, Okla.	Nat. Gasoline	4,800 bbls.	$4 million	PAD Certified	Early 1953			
Consumers Coop	Phillipsburg, Kans.	Cat. Crk. Unit	5,000 bbls.	$2.6 million	Under Constr.	Feb., 1953	U.O.P.	Ref. Eng.	Ref. Eng.
		Dist. Expansion	14,000 bbls.		Under Constr.	Mid 1953		Ref. Eng.	Ref. Eng.
Continental Oil	Ponca City, Okla.	Expansion	None	$7.5 million	Start Spring	Mid 1953	Continental	Staff	Staff
Deep Rock Oil	Cushing, Okla.	Aromatics Fac.		$3,250,000	PAD Certified				
Deep Rock Oil	Cushing, Okla.	Lube Oil Plt.	1,050 bbls.	$2 million	Engineer	Mar., 1953	JUIK	Kellogg	Kellogg
Detroit Chem. Wks.	Detroit, Mich.	Sulfuric Acid		$950,000	PAD Certified				
Dow Chemical	Midland, Mich.	2nd Hypersorption Unit			Under Constr.		Union Oil (Calif.)	Foster Wheeler	Foster Wheeler
Dow Chemical	Ludington, Mich.	Bromine for TEL	2 million lbs. yr.	$433,500	Under Constr.				
Dow Chemical	Midland, Mich.	Ethylene Dibromide		$370,000	Under Constr.				
Dow Chemical	Midland, Mich.	Vinyltoluene Plt.		$8 million	Completed			Stone & Webster	Stone & Webster
Dow-Corning	Midland, Mich.	Methyl Chloride		$820,000	Completed			Staff	Staff
El Dorado Refining	El Dorado, Kans.	Expansion	14,000 bbls.	$3 million	Under Constr.	Mid 1953	U.O.P.	Ref. Eng.	Ref. Eng.
*Globe Oil and Refg.	Lemont, Ill.	Alkylation Unit	15,000 bbls.	$4 million	Planning	March, 1954	U.O.P.	U.O.P.	Staff
Great Northern	St. Paul, Minn.	Crude Topping	30,000 bbls.						
Great Northern Oil	St. Paul	Cat. Crk.	7,620 bbls.	$26 million	Certified DPA				
Great Northern	St. Paul	Cat. Reformer	6,000 bbls.						
Great Northern	St. Paul	Cat. Poly.	880 bbls.						
Gulf Oil	Cincinnati, Ohio	Canning Plt.			Announced				
International Refineries	Carlton City, Minn.	Refinery	11,500 bbls.	$7 million	Completed		S.O.D.	Lummus	Lummus
Kanotex Refining	Arkansas City, Kans.	Vacuum Unit	4,600 bbl.	$2.4 million	Completed		U.O.P.	U.O.P.-Ref.Eng	Ref. Eng.
Kanotex	Arkansas City	Fluid Cat.	5,700 bbl.						
Lakeside Refining	Kalamazoo, Mich.	Cat. Reformer	1,500 bbls.	$300,000	Under Constr.	Dec., 1952	Phillips	Koch	Staff
Leonard Refineries	Alma, Mich.	Expand. Crk. Capacity	14,000 bbls.					Cat. Constr.	Cat. Constr.
Lion Oil	El Dorado, Ark.	Av-Gas Expan.	432 bbl.	$810,000	Under Constr.				
Lion Oil	El Dorado, Ark.	Cat. Crk. Unit	5,000 bbls.	$5 million	Announced	Late 1953			
Lion Oil	El Dorado, Ark.	Alkylation Plt.	1,150 bbls.						
Mercury Oil Refining	Oklahoma City	Cat. Crk.; Poly.	2,500/360 bbl.	$3.2 million	Engineering	Late 1952	U.O.P.	Ref. Eng.	Ref. Eng.
Mercury	Oklahoma City	Topping; Thermal	5,900/1,600 bbl.						
Michigan Chem.	St. Louis, Mo.	Sulfuric Acid		$81,681	PAD Certified				
Mid-Continent Pet.	Tulsa Co., Okla.	Aviation Gaso.		$119,572	Certified DPA				
Midland Coop. Wholesale	Cushing, Okla.	Capacity Exp.	14,000 bbls.	$3 million	Under Constr.	May, 1953	U.O.P.	UOP & Ref. Engineers	Refinery Engineers
Minnesota Mining	Copley Twp., Ohio	Sulfuric Acid Fac.		$2.1 million	Under Constr.				
Monsanto Chemical	Addyston, Ohio	Styrene Plastics			Plan				
Natl. Petro Chemicals Corp.	Tuscola, Ill.	Ethane-Propane Nat. Gas		$32 million	Announced	Late 1952			
Natl. Petro Chem.	Tuscola, Ill.	Petro Chem Plt.	500 mcmcf	$32 million	Under Constr.	Late 1952			Vulcan, Pritchard, Foster Wheeler, Lummus
Northern Nat. Gas.	Holcomb, Kans.	Gas Dehydra.			Completed			Dresser	Dresser
Northern Nat. Gas.	Holcomb	Gas Rcfg. Plt.	185,000 mcfd		Completed			Dresser	Dresser
Northwestern Refining	St. Paul Park, Minn.	Topping & Cracking Unit	30,000 bbl.	$2 million	Under Constr.	Aug., 1953		U.O.P.	Procon
Ohio Oil	Robinson, Ill.	Coking Unit	5,000 bbls.		Under Constr.	April, 1953			Lummus
*Ohio Oil Company	Robinson, Ill.	Houdriforming	8,000 bbls.		Planning	Late 1953	Houdry		Cat. Constr.
Ohio Standard	Cleveland, O.	Crude Topping	7,500 bbl.	$4.2 million	Design				
Ohio Standard	Cleveland	Cracker; Poly.	18,000 40 bbl.						

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Oklahoma Refg. Co.	Seminole, Okla.	Refinery	200 bbls.	$40,000					
Old Dutch Refining	Muskegon, Mich.	Aromatic Fac.	150 B 370 T.	$515,130	Under Constr.				
Pana Refining	Pana, Ill.	Girbotol Unit			Under Constr.				Parker
Petroleum Specialties	Flat Rock, Mich.	Cat. Cracker	3,000 bbls.	$2 million	Planning				
Phillips Petroleum Co.	Okmulgee, Okla.	Cat. Crk. with Feed Prep. Unit & Gas Plt.		$4.5 million	Completed			Fluor	Fluor
Pure Oil	Smiths Bluff, Ark.	Alkylate Fac.		$390,000	Under Constr.				
Pure Oil	Toledo, Ohio	Alkylation Unit (Sulfuric Acid)		$2.5 million	DPA Ok'd Planning				
Pure Oil	Toledo, Ohio	Modernization	30,000 bbls.		Start May	Spring 1953		Kellogg	Kellogg
Pure Oil	Toledo, Ohio	Orthoflow Cat.	15,000 bbls.		Start May	Spring 1953		Kellogg	Kellogg
Roosevelt Oil & Refining	Mt. Pleasant, Mich.	Benzene Plt. and Auxiliary	1,140 bbls.	$1.5 million	Completed		U.O.P.	U.O.P.	Procon
Roosevelt O&R	Mt. Pleasant,	Platformer	1,750 bbls.		Under Constr.		U.O.P.	U.O.P.	Procon
Roosevelt O&R	Mt. Pleasant,	Udex Unit	1,200 bbls.	$1.5 million	Completed		U.O.P.	U.O.P.	Procon
*Shell Oil Co.	Wood River, Ill.	Platformer	16,000 bbls.		Under Constr.		U.O.P.		Procon
*Shell Oil Co.	Wood River, Ill.	Vacuum Flasher		$1,145,000	Design			Bechtel	Bechtel
Shell Oil	Wood River, Ill.	Expansion and Improvement	150,000	$42.5 million	Under Constr.	Late 1953		Shell	Foster-Wheeler Fluor
Sinclair Refining	Hartford, Ill.	Gasoline Fac.		$34.4 million	PAD Certified				
Sinclair Refining	Hartford, Ill.	Crude Expansion	137,000 bbls.		PAD Certified				
Sinclair Ref.	Wood River, Ill.	Sulfur Extrac.	10,000 bbls.			Jan., 1953		Badger Div.	Badger Div.
Skelly Oil	Velma, Okla.	Booster Station			Planned				
*Socony-Vacuum	Trenton, Mich.	Cat. Poly. Unit							
*Socony-Vacuum	Augusta, Kans.	T C R		$3 million	Design	Early 1954		Bechtel	Bechtel
Socony-Vacuum	E. St. Louis, Ill.	Alky. Unit Rehab.	775 bbls.	$260,000	Design				
Socony-Vacuum	E. Chicago, Ind.	Avgas Facilities		$3 million	Plan				
*Spencer Chemical Company	Vicksburg, Miss.	Petrochemical	200 tons	$14 million	Under Constr.	Late 1953		Foster Wheeler Staff	Foster Wheeler Quaker
Standard-Ind.	Neodesha, Kans.	Cat. Crk.; Alky.	9,300 bbl.	$10 million	Under Constr.	End 1952			
Standard-Ind.	Sugar Creek, Mo.	Crude Expan.	30,000 bbl.	$21 million	Preparing	End 1952			
		Olefin Concentrate	320 bbls.	$142,000	Under Constr.	End 1952			
*Standard-Indiana	Wood River, Ill.	Fluid Hydroformer	9,000 bbls.		Design	1954			
Standard (Ind.)	Wood River, Ill.	Additives Plt	4,000 gals.		Design	1953		Staff	Staff
Standard-Ind.	Wood River, Ill.	Alcohols Prod.	30,000 lbs.	$2.6 million	Under Constr.	End 1952			
Standard-Indiana	Whiting	Benzene Expan.	1,044 bbls.		Completing				
Standard (Indiana)	Williston Basin, N. D.	New Crude Refinery	30,000 bbls.		Under Constr.	1954			
Standard Oil of N.D.	Grand Forks, N. Dakota	Refinery	2,000-2,500 bbls		Planning				
Standard (Ohio)	Cleveland, Ohio	Crd. Dist. Plt.	45,000 bbls.	$6½ million	Completed			McKee	McKee
Standard-Ohio	Toledo, Ohio	Alkylation Unit		$3 million	Under Constr.	Mid 1953		McKee	McKee
Standard-Ohio	Lima, Ohio	Crude Coking—		$2.4 million	Engineering		U.O.P.	Lummus	
		Cat. Reforming	3,000 bbls.	$8.5 million	Engineering	Mid 1954			
Standard (Ohio)	Cleveland, Ohio	Alkylation Feed		$6.7 million	Certified DPA				
Stanolind Oil & Gas Co.	Tulsa, Okla.	Research Center			Under Constr.	May, 1953		Shreve, Lamb & Harmon Stearns-Roger	Manhattan Stearns-Roger
Stanolind Oil & Gas	Grant Co., Kans.	Isobutane Mfg.	225 MMCF	$1 million	Completed				
Sun Oil	Toledo, Ohio	Platform Unit	15,000 bbls.		Under Constr.		U.O.P.		
Sunray Oil	Duncan, Okla.	Alkylation Fac.	2,400 bbls.	$1.7 million	Under Constr.	Spring, 1953	U.O.P.	Ref. Eng.	Ref. Eng.
Texas Co.	Lawrenceville, Ill.	Expand Refinery	20,000 bbls.		Completed			Foster Wheeler, Kellogg	Foster Wheeler, Kellogg
Texas Natural Gasoline	Tulsa, Okla.	Gasoline, Propane, Butane			Announced				
The Texas Co.	Lockport, Ill.	Lube Oil Plt.	3485 bbls.	$17.6 million	Certified DPA				
The Texas Co.	Lockport, Ill.	Crude Expan.,	25,000 bbls.	$15 million	Not Certified				
Tide Water Assoc. Oil	Drumright, Okla.	Crude Topping; Vacuum	15,000 bbl. 6,000 bbl.		Design			Ref. Eng.	Ref. Eng.
Vickers Petroleum	Potwin, Kans.	Crude Expan.	10,000 bbls.		Under Constr.	Jan 1, 1953		Koch	Koch
Vickers Petroleum	Potwin, Kans.	Thermofor Cat. Cracking			Under Constr.	Jan., 1953	So-Vac.	Sweco	Sweco
Warren Petroleum	Cronsville, Ill.	Isopentane Fac.		$40,350	PAD Certified				
Warren Petroleum	Tulsa, Okla.	Propane & Butane		$566,320	Certified DPA				
White Eagle Petroleum	Augusta, Kans.	Therm. Cat. Reform			Projected				
Wilcox Oil	Bristow, Okla.	Cat. Platformer	1,500 bbl.	$1 million	Completing		U.O.P.	Procon	Procon
Williston Refining	N. Dakota	Complete Refg.	10,000 bbls.	$5 million	Announced		U.O.P.		
Wood River Oil Refining	Calumet, Ill.	Crude Topping, Crak.; Poly.	15,000 bbl. 6,800/600 bbl.	$1 million	Design				
SOUTHWEST									
Acadia Corp.	Shreveport, La.	Motor gas unit		$2.9 million	Design				
Allied Chemical & Dye (Solvay)	Orange, Texas	Petrochemicals Unit		$5 million	Projected	2 years			
*American Cyanamid Company	New Orleans, La.	Petrochem. Plt.		$50 million	Projected				
*American Liberty Oil Company	Mt. Pleasant, Texas	T. C. C. Unit Gas Fract. Unit Feed Prep. Unit	5,120 bbls.		Engineering	1953	Sun-Vac.	Fluor	Fluor
American Petro-Chemical Corp.	Lake Charles, La.	Chem. Plt.	$15-20 million		Planned				
*American Republics Corp.	Hardin County, Texas	Remote Absorber	30 MMCF		Under Constr.	1952			
*Anchor Gasoline Corp.	North Tepetate, La.	Gasoline Plt.	300 bbls.		Under Constr.	Mid 1953			
Aqua Dulce	Banquette, Tex.	Cycling Expan.		$750,000	Completed			Fish Eng.	Fish Eng.
*Arkansas Fuel Oil Company	Haughton, La.	Gas Plt. Cap. Increase	60 MMCF		Under Constr.	Late 1952		Staff	
*Arkansas Fuel Oil Co.	Heflin, La.	Gas Increase	60 MMCF		Under Constr.	Late 1952		Staff	
*Arkansas Fuel Oil Company	Carthage, Texas	Increase Butane & Propane Rec.	100 MMcf		Projected	Mid 1953		Staff	
*Arkansas Fuel Oil Company	Jefferson, Texas	Increased LPG Rec.	31 MMcf		Under Constr.	Early 1953		Staff	
Aromatics Refining	Baton Rouge, La.	Aromatics Fac.		$11.6 million	Design				
Atlantic Refining Co.	Port Arthur	Detergent Mfg.		$1.5 million	Completing		Atlantic	Atlantic	Badger Div.
*Atlantic Ref. Co.	Pt. Arthur, Tex.	Chem. Expan.	90 tons		Under Constr.	End 1952	Badger	Staff	
Barnsdall Oil Co., Op.	Scurry Co., Tex.	Natl. Gaso. Plt.	50,000 mcf gas	$6.5 million	Considering				
*Bennett Oil & Refining Company	Refugio, Texas	Increase Comp. Capacity	2.5 MMcf		Planned	1952			
*J. R. Butler Interests	Howard County, Texas	Natural Gasoline Plt.			Planned				
Cabot Carbon Co.	Bayou Sale, St. Mary Parish, La.	Thermal Black Plt.	136,986 lbs.	$4 million	Designing	1952			

• Continued on page 81

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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

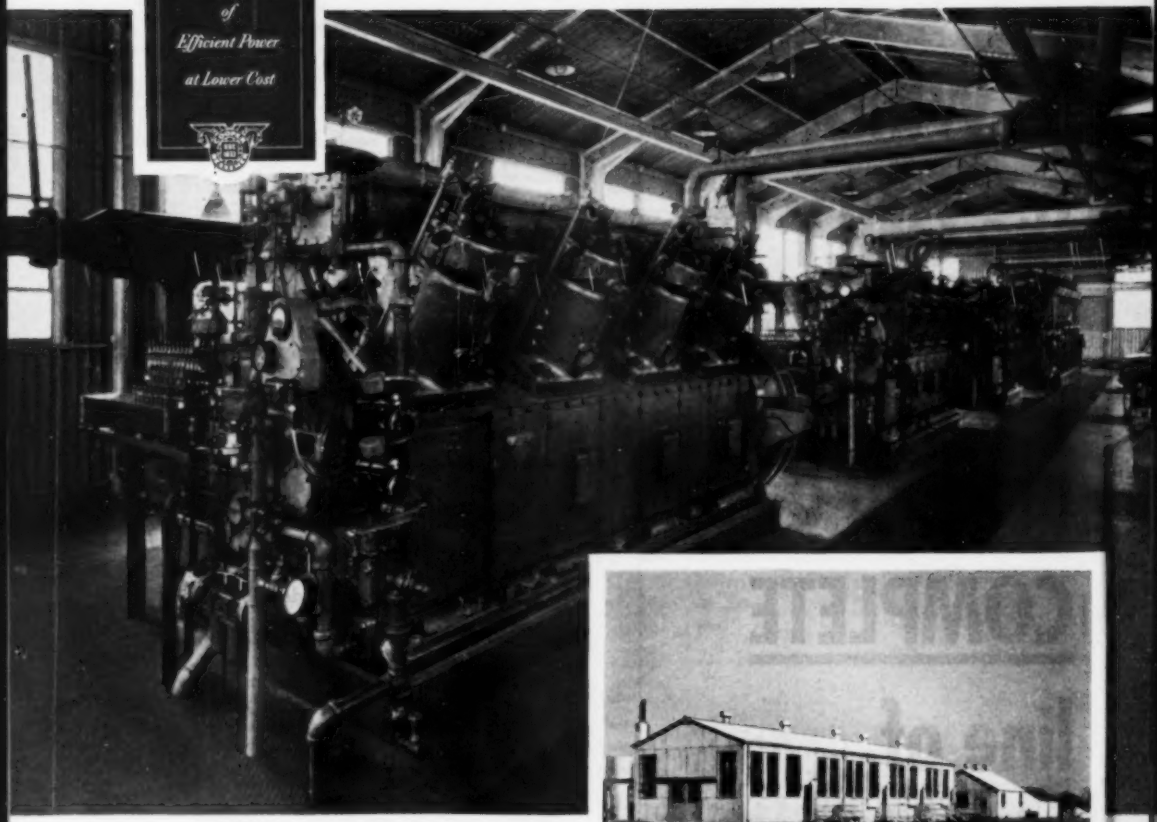
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Carbide & Carbon	Texas City, Tex.	Acetylene Plt.			Under Constr.	Early 1953			
Carbide & Carbon	Texas City, Tex.	Poly. Resins	140,000 lbs.		Under Constr.	Early 1953			
Carbide & Carbon Corporation	Seadrift, Texas	Polyethylene & Ethylene Glycol Mfg.	140,000 lbs.	$43 million	Under Constr.	Early 1953			
Celanese Corp.	Pampa, Tex.	Chem. Plt.		$3.5 million	Completing			Brown & Root	Brown & Root
Cities Service	Lake Charles, La.	Fluid Hydroformer	19,000 bbls.		Engineering			Kellogg	Kellogg
Cities Service Oil	Pampa, Texas	Gasoline Expan.		$222,130	Certified DPA				Parsons
*Columbia Southern Chemical Co.	Corpus Christi, Texas	Chlorine & Caustic Unit			Under Constr.	End 1952	Staff	Tellepsen	Tellepsen
		Hydration Plt.			Under Constr.	End 1952	Staff	Tellepsen	Tellepsen
Cob-Tex Refining Co.	Colorado City, Texas	Platforming Unit			Planned				
Consolidated Chem.	Baton Rouge	Sulfuric Acid	400 tons	$3.5 million	Under Constr.	Nov., 1952		Chemico	Chemico
*Consolidated Chemical Industries, Inc.	Baytown, Texas	Acid Unit	600 tons		Planning	End 1953			
	Baton Rouge, La.	Acid Unit	500 tons	$3.5 million	Under Constr.	End 1952			
Continental Oil	Lake Charles, La.	Refinery Expan.	40,000 bbl.	$24 million	Under Constr.	Jan., 1953	U.O.P.	Badger Div., Conoco	Badger Div., Procon
Coseden Petroleum Corp.	Big Spring, Texas	Platforming and Udex Units	4,000 bbls.	$8 million	Completing		U.O.P.-Dow	U.O.P.-Dow	Procon
Crown Central Petroleum	Houston, Texas	Crude Topping	2,350 bbl.	$205,000	Design				
Crown Central	Houston	Cat. Cracker	2,400 bbl.						
Davison Chemical	Lake Charles	Catalyst Plt.		$7 million	Under Constr.	Early 1953		D & Z	Consd. Eng.
Del Rey Petroleum Co.	Chesterville, Texas	Pressure Absorption Plt.	28,000 mcf		Under Constr.			O. L. Olson	O. L. Olson
Del Rey Petroleum	Eagle Lake, Tex.	Nat. Gasoline		$4,000	Certified DPA				
Del Rey Petroleum	Eagle Lake, Tex.	Butane & Propane			Certified DPA				
*Delta Chemical Co.	Pointe a la Hache, La.	Petrochemical Plt.			Planned				
Diamond Alkali	Houston, Texas	Petrochemicals		$2 million	Contracted				Brown & Root
Dow Chemical	Freeport, Texas	Styrene Plastics		$1.6 million	Under Constr.			Braun	Braun
Dow Chemical	Freeport	Ethylene-Dibromide Unit		$3 million	Under Constr.			Braun	Braun
Dow Chemical	Freeport	Perchloroethylene Chloride		$3 million	Under Constr.			Braun	Braun
Dow Chemical	Freeport, Texas	Benzene Addi.		$1.2 million	Certified DPA				
*Dow Chemical Co.	Freeport, Texas	Ethyl-Dow Plt.			Under Constr.	Early 1953	Staff	Staff	Tellepsen
Dow Chemical	Texas City, Tex.	Research Fac.		$3.6 million	Under Constr.	1953			Southwestern
Du Pont	Beaumont, Tex.	Petrochemicals Unit			Begin 1953				
E. I. Du Pont de Nemours & Co., Inc	Orange, Texas	Expand Polythene Manuf. Facilities	60 mmcf		Under Constr.	Late 1953			
Eastern States Pet.	Houston Texas	Ethylene Mfg.		$4 million	Projected			U.O.P.	
Eastern States Pet.	Houston Texas	Rehab. Closed Plt.			Army Contract				
Esso Standard	Baton Rouge	Aromatics Fac.			Under Constr.				Staff
Esso Standard	Baton Rouge	Crude Distill.	300,000 bbls.	$51 million	Under Constr.	Early 1953		S.O.D.	Kellogg
Esso Standard	Baton Rouge	Cat Cracker	31,000 bbls.		Under Constr.	Early 1953		S.O.D.	Kellogg
Esso Standard	Baton Rouge	Crude Pipe Still	60,000 bbls.		Under Constr.	1954		Kellogg	Kellogg
Esso Standard	Baton Rouge, La.	Iso-octyle & Trideoyl Mfg. (alcohol)		$320,000	Announced				
Ethyl Corp.	Houston, Texas	Chemicals Mfg.	100 mln. lbs./yr.		Completing			Braun-Badger Div.	Braun-Badger Div.
*Ethyl Corp.	Baton Rouge	BHC Plt.			Under Constr.	End 1953	Staff	Tellepsen	Tellepsen
Ethyl-Dow	Freeport, Texas	Ethylene Dibromide	60,000 lbs.	$3.2 million					
Freeport Sulphur	Garden Is. Bay, La.	Sulfur Mining	1,400 tons	$10-15 million	Engineering	1953			
*General Crude Oil Co.	Kent County, Texas	Extraction Plt.			Planned				
Gilmore Refineries	Odessa, Texas	New Refinery	50,000 bbls.	$40 million	Design				Ford-Bacon-Davis
Great Southern	Corpus Christi	Platformer Off		$5 million	Engineering	3rd Qtr., 1953		Fluor	Fluor
*Great Southern Chemical Corp.	Corpus Christi, Texas	Platforming and Udex Units	4,000 bbls.		Design	1953	U.O.P.	U.O.P., Procon	Procon
Gulf Oil	Crane Co., Tex.	Sulfur Unit		$200,000	Certified DPA				
Gulf Oil	Pt. Arthur, Tex.	Ethylene Plt.	45,000 lbs.	$15.4 million	Completing			Lummus	Lummus
Gulf Oil	Port Arthur	Sulfuric Acid	300 tons	$2,318,855	Under Constr.	Late, 1953		Leonard Constr.	Leonard Constr.
Gulf Oil	Port Arthur	Polymerization		$2,145,000	Under Constr.	Summer, 1953		Bechtel	Bechtel
Gulf Oil	Port Arthur	Sulfur Recovery	60 tons	$586,200	Designing	Fall 1952		Parsons	Parsons
Gulf Oil	Waddell, Texas	Sulfur Extrac.	20 tons		Completing			Graff	Graff
Heyden Chemical	Houston, Texas	Methanol fr Natural Gas		$12 million	Announced				
Humble Oil	Baytown, Texas	Sulfuric Acid		$808,000	Announced				
*Humble O&R Co.	Baytown, Texas	Cat. Light Ends Recovery Unit	37 MMcf 19,400 bbls.	$4 million	Planning	4th Qtr., 1953		Fluor	Fluor
*Humble O&R Co.	Baytown, Texas	Propane Deasphalting Unit		$5 million	Awaiting Materials	Oct., 1953			Kellogg
Humble O&R	Pickton Field, Texas	Gas Comp. Plt.	130.6 mmcf		Under Constr.	End, 1953			Stearns-Roger
Humble O&R Co.	Baytown, Texas	Paraxylene Plt.	66,000 lbs.		Planned	May, 1953			C. F. Braun
Jefferson Chemical	Port Neches, Texas	Ethylene Oxide			DPA Certified				
		Ethylene Glycol							
Jefferson Chemical	Port Neches	Phenol Mfg.			Under Constr.	July, 1953			
*Jergins Oil Co. of Texas	Dewitt, Texas	Comp. Stripper Plt.			Authorized				
*Kerr-McGee Oil	Moore Co., Tex.	Natural Gaso.	55 MMcf	$850,000	Under Constr.	Early 1953		Dresser, Staff	Dresser
Koppers Co., Inc.	Pt. Arthur, Tex.	Chem. Plt.		$6 million	Completing			Koppers	Koppers
Levelland Refining	Levelland, Texas	Cat. Crk: Poly.	3000/150 bbls.	$2.4 million	Design				
Lion Oil Co.	Luling, La.	Chemical Plt.	300 tons	$31 million	DPA Certified				
Lone Star Producing Company	Ft. Chadbourne, Texas	Gasoline Plt.	30 mmcf	$3 million	Under Constr.				
Magnolia	Hurricane Creek Field, Beauregard Parish, La.	Casinghead Gasoline Plt.			Designed				
Magnolia Petroleum	Beaumont, Tex.	Therm. Cat. Reforming	17,000 bbls.	$10 million	Projected		So-Vac.		
*Magnolia Petroleum	Chaison, Texas	Cooling Facil.			Engineering	1st Qtr. 1953		Fluor	Fluor
Magnolia Petroleum	Midland Co., Texas	Nat. Gas & Butane		$5.3 million	Certified DPA				
Mayfair Minerals	McAllen, Texas	Natural Gas Plt.			Announced				
McBride Refining	Edinburg, Tex.	Modernization	3,500 bbls.		Under Constr.				
McBride Refining	Edinburg, Tex.	Cat. Reform.	800 bbls.		Completing				
Monarch Refining	San Antonio, Texas	Fluid Cat. Crk.	4,000 bbl.						
Monarch	San Antonio	Poly. Unit	2,500 bbl.	$12.5 million	Design	Mid 1953		U.O.P.	Koch
Monarch	San Antonio	Alky. Unit	2,500 bbl.						

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Monsanto	Texas City	Styrene Plastics		$8.6 million	Completing				
Monsanto	Texas City, Tex.	Vinyl Chloride		$7.3 million	Announced				
Monsanto Chemical Co.	Texas City, Tex.	Acrylonitrile Mfg. Facil.; Plt. Expansion		$30 million	Engineering	1952		Braun	
*Monsanto Chemical	Texas City, Tex	Oxygen Plt.	600 tons		Under Constr.	End 1952	Hydrocarbon	Hydrocarbon	Tellepsen
*Natural Gasoline Co.	Hawkins, Texas	Plt. Expan.	43 MMcf.		Under Constr.	End 1952			
Onyx Refining Co.	Abilene, Texas	Platformer Expansion	650 bbls. †500 bbls.		Design Planned	1st Qtr., 1953	UOP	Procon	Procon
Pan Am Petroleum & Trans.	Texas City, Tex	Av-Gas Expan.	†1,150 bbls.		Plan	End 1952			
Pan Am Southern Corp.	Destrehan, La.	Cat. Crk., Gas, Alkylation	12,000 bbls. 2,500 bbls.	$6.5 million	Under Constr.	Oct., 1953		Lummus	Lummus
Pan-Am Southern	Destrehan, La.	Refinery Expan.		$5.5 million	Completing				
Pan-Am Southern	Destrehan, La.	Fluid Hydro-former	2,000 bbl.		Under Constr.	Oct., 1953		Kellogg	Kellogg
Pan-Am Southern	Destrehan, La.	Coker	9,000 bbls.		Under Constr.	January, 1953		Lummus	Lummus
Pan American	Texas City	Refinery Expan.	†12,000 bbls.		Begin 1952				Lummus[1]
Pan American Refining	Texas City, Texas	Fluid Cat[1]	†30,000 bbls.[1] Cracking	$1.8 million					Texas-Gulf
Pan American	Texas City	Poly Unit	†2,400 bbls.						
Panhandle Prod. & Ref.	Wichita Falls, Texas	Topping Unit	9,000 bbl.		Design			Ref. Eng.	
Panoma Corp.	Carson Co., Tex.	Avgas	14,611 gals.	500,000	Completing			Gas Plt. Constr.	Gas Plt. Constr.
Pecos Petroleum	Pecos, Texas	Aromatics Expansion	240,/260 bbls.		Planned				
Phillips Chemical	Houston, Texas	Chem. Plt.		$2.5 million	Under Constr.	1953			
Phillips Oil	Borger, Texas	Alky. Expan.		$15.5 million	Announced				
Phillips Pet.	Alvin, Texas	Nat. Gas Expan.	3,570 bbl.		Under Constr.	End, 1952	Staff	Staff	Tellepsen
Phillips Pet. Co.	Brazoria Co., Texas	Natural Gasn.	†100,000 cu. ft.		Under Constr.	Nov., 1953		Phillips	Phillips
Phillips Pet.	Midland, Texas	Nat. Gas Plt.	100 mcf		Under Constr.				
Phillips Petroleum	Sherman County, Texas	Natural Gas Plt		$212,000	Under Constr.				
Phillips Petroleum	Houston, Texas	Petrochemicals	400 tons	$38 million	Under Constr.	2nd Qtr., 1953		Phillips	Fish
Phillips Petroleum	Gray Ctv., Tex.	Natural Gasoline		$409,612	PAD Certified				
Phillips Petroleum	Hutchinson City, Texas	Natural Gasoline Equip.		$159,165	PAD Certified				
Phillips Petroleum	Moore Ctv.,Tex.	Natural Gasoline		$1 million	PAD Certified				
Phillips Petroleum	Midland, Texas	Expanded Gasoline Mfg.	†60,000 cu. ft.	$9.6 million	Completing			Staff	Staff
Phillips Petroleum	Ector Co., Tex.	Butanes-Pentanes Mfg.		$5.4 million	Certified DPA				
*Phillips Pet. Co.	Phillips, Texas	Cyclohexane Con. Fac.		$976,900	Authorized				
*Phillips Petroleum	Sweeny, Texas	Gaso. Procem			Engineering	1 Qtr., 1954		Fluor	Fluor
Phillips Petroleum	Borger, Texas	Cyclohexane Mfg.		$1.5 million	Certified DPA				
Phillips Petroleum	Borger, Texas	Propane & Isobutane		$2 million	Certified DPA				
*Phillips Pet. Co.	Sprayberry Trend, Texas	Natural Gasoline Plt.	60,000 cf.		Projected				
Phillips Pet. Co.	Upton Co., Tex.	Natural Gaso.	†30,000 cu. ft.		Under Constr.	May, 1953		Phillips	Phillips
*Plymouth Oil Co.	Tom Greene County, Texas	Repressure and Gas Lift Plt.	3 MMCF		Under Constr.	1952			Hudson
Pontiac Refining	Corpus Christi	Avgas Expan.		$2 million	PAD Certified				
Premier Pet.	Ft. Worth	Jet Fuel Butane, etc		$3.6 million	Design				
Premier Petroleum	Ft. Worth, Tex.	Refinery Expan.	6,000 bbls.		Planned				
Pure Oil	Smiths Bluff	Basic Refining		$10.8 million	Announced				
Pure Oil	Smiths Bluff	Alkylate Unit	1,901 bbl.	$390,000	Announced				
Pure Oil	Smiths Bluff	Cat. Poly.	135		Start 1952			Kellogg	Kellogg
Pure Oil	Smiths Bluff	Expan. Alkyl.	1,900 bbls.	$390,000	Start 1952			Kellogg	Kellogg
Pure Oil	Smiths Bluff	Modernization		$11 million	Under Constr.	Spring, 1953		Kellogg	Kellogg
Pure Oil	Smiths Bluff	Orthoflow Crk.	15,000 bbls.						
*Pure Oil Co.	Smiths Bluff	Power Expan.			Under Constr.	Early 1953	Staff	Staff	Tellepsen
Pure Oil	Smiths Bluff, Tex.	Feed Prep-Vac Flash	20,000 bbls.		Start 1952			Kellogg	Kellogg
*Reef Fields Gasoline Corporation	Sweetwater, Tex.	Gasoline Plt.			Planned				
Republic Oil Ref.	Texas City, Tex.	Platforming Unit	6,500	$7 million	Under Constr.	Spring, 1953	U.O.P.	Procon	Procon
Republic Oil Ref.	Texas City, Tex.	Crude Dist.	†30,000						
Republic Oil Refining	Texas City, Tex.	Gasoline Mfg.		$6.6 million	Announced				
*Runnels Gas Products Corp.	Runnels Co., Texas	Gaso. & Press. Maint. Plt.	20 MMcf	$3 million	Planning				
Shamrock Oil & Gas Corp.	McKee, Texas	Gaso. Ref. Treater		$80,000	Planning				
Shamrock Oil & Gas	Sunray, Texas	Coking Unit	1,600 bbls.	$500,000	Completing		Lummus	Lummus	Lummus
Shamrock O&G	Sunray, Texas	Aviation Alky.	16,000 bbls.	$2 million	Announced	March, 1953		Kellogg	
Shamrock O&G	Sunray, Texas	Sulfur Extrac.	35 tons	$195,500	Completing				
Shell Chemical	Houston, Texas	SBA-MEK Expansion			Under Constr.	Dec., 1952		Pioneer	Pioneer
Shell Chemical	Houston, Texas	Sulfur Recov.	55 tons	$500,000	Completing			Parsons	Parsons
Shell Chemical	Houston, Texas	Epon Resins		$1.5 million	Engineering	Sept., 1953		Badger, Fluor	Badger, Fluor
*Shell Chemical	Deer Park, Tex.	Ethyl. Alt.			Engineering	2nd Qtr., 1953		Fluor	Fluor
Shell Oil	Houston, Texas	Benzene-Toluene	1,250/2,500 bbl.	$4.6 million	Under Constr.	Late 1952		Foster Wheeler and Fluor	Foster Wheeler and Fluor
Shell Oil Co.	Houston, Texas	Platforming Unit	16,000 bbl.	$12 million	Under Constr.			U.O.P.	Procon
Shell Oil	Norco, La.	Expansion	†25,000 bpd	$30 million	Design				
Shell Oil	Houston, Texas	Avgas Components		$1 million	Certified DPA				
Shell Oil Co.	DeWitt & Victoria Cos., Tex.	Gas Comp. Plt.	12 mmcf		Under Constr.	Nov., 1953			Olsen
Sid N. Richardson	Odessa, Texas	Sulfur Recovery	20 tons	$130,830	Under Constr.	1952		Graff	Graff
Sid Richardson Refining Co.	Texas City, Tex.	Refinery Alterations	30,000 bbls.		Under Constr.			Staff	Staff
Sinclair Refining	Houston, Texas	Crude Dist. and Vacuum Units	25,000 bbl.	$33.6 million	Under Constr.	Fall 1953		Staff-Fluor	Fluor
Sinclair	Houston	Cat. Cracker and Gas Plt.	40,000 bbl.						
Sinclair Refining	Houston Texas	Barium Sulfonate		$145,700	Certified DPA			Braun	Braun
*Socony-Vacuum	Beaumont, Tex.	T C R							
South Texas Corp.	Neuces Co., Tex.	Expanded Products Mfg.			Announced				
Southwestern Oil & Refining	Corpus Christi, Texas	Crude Topping	15,300 bbl.	$5.5 million	Under Constr.	Mid 1953	U.O.P.	Ref. Eng.	Ref. Eng.
Southwestern	Corpus Christi	Cat. Crk.-Poly.	5,000/200 bbl.						
Standard (Texas)	El Paso, Texas	Alkylation Unit	1,400 bbl.	$2.7 million	Completed		Kellogg	Kellogg	Cat. Constr.
Standard (Texas)	El Paso	Expansion & Modern Crk.	11,000 bbl.	$10.2 million	Completing		Houdry	Cat. Constr.	Cat. Constr.
Standard (Texas)	Houston, Texas	Natural Gasol		$1.2 million	Announced				
Stanolind Oil	Shreveport, La.	Gas Stripping	1.5 million cu. ft.		Completed			Blaw-Knox	Blaw-Knox

* Continued on Page 85

Another Example of Efficient Power at Lower Cost



COOPER-BESSEMER V-ANGLES ON THE JOB

Conserving Gas and Dollars

AT LONE STAR GAS COMPANY'S KATIE PLANT

THE answer to efficient, low-cost compressor service at Lone Star Gas Company's gasoline extraction plant in the Katie Field is this 2,560-horsepower line-up of Cooper-Bessemer V-angles. These units, 3 GMX's and a GMV, compress casinghead and low pressure distillate gas from about 60 psi suction to 415 psi discharge, for delivery to the absorber.

Of particular interest, the engines have automatic speed control and drive compressor cylinders selected for a wide range of operation without the use of unloading equipment. Add to this the fact that *every crankthrow*, all down the line, drives a compressor cylinder. Here's an economical, easy-to-maintain setup that makes the most of Cooper-Bessemer V-angle compactness.

The **Cooper-Bessemer** *Corporation*

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Q. Which is the ONLY company making a COMPLETE line of gasoline additives?

A. DUPONT is the only company making a complete line of gasoline additives! This line includes antioxidants, metal deactivator and gasoline dyes as well as tetraethyl lead antiknock compound.

Tetraethyl lead was first made commercially by a process developed by Du Pont in 1923 and, from that year until September 1945, Du Pont was the sole manufacturer of tetraethyl lead in the United States.

▶ As in the case of TEL, all Du Pont additives are backed by a comprehensive technical service program. This program is brought to you by experienced representatives who are supported by the 5 thousand Du Pont personnel engaged in research and its administration.

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Petroleum Chemicals

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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Stanolind O&G	Sundown, Texas	Gas Plt. Increase	†23 MMCF		Under Constr.	Jan., 1953		Staff	Blaw-Knox
Stanolind O&G	Sundown, Texas	Sulfur Recovery	49 long tons		Completed			Fluor	Fluor
Stanolind O&G	Odessa, Texas	Sulfur Rec. Plt.	17.7 long tons		Under Constr.	Early 1953		Girdler Corp.	Girdler Corp.
Stanolind O&R	Andrews Co., Texas	Nat. Gasoline	11 MMCF	$2.7 million	Under Constr.	Dec., 1952		Hudson	Hudson
Sunray	Corpus Christi	Cat. Cracker	28,000 bbls.	$16 million	Under Constr.	Summer 1953	U.O.P.	Lummus	Lummus
*Sunside Ref. Co	Corpus Christi	Crude Oil Ref.	25,000 bbls.	$15 million	Under Constr.	1953	U.O.P.	U.O.P.-Lummus	Lummus
*Taylor Oil & Gas Company	Corpus Christi Texas	Platform. Unit	5,000 bbls.		Planning	July, 1953	U.O.P.	U.O.P.	Staff
Taylor O&G Co.	Corpus Christi	Aromatics Fac.	3,750 bbls.	$3.7 million	Engineering	June, 1953	UOP	UOP	Staff
*Texas City Chemical	Texas City, Tex.	Dicalcium Phosphate Plt.	300 tons	$7 million	Under Constr.	June, 1953	Chemico	Chemico	Chemico
		Sulfuric Acid Plt.	300 tons						
Texas City Refining	Texas City, Tex.	Modernization		$3 million	Engineering	1953		Henry Kaiser	Henry Kaiser
Texas City Refining	Texas City, Tex.	Modernization		$3 million	Eng. Studies	1953		Henry Kaiser	
Texas City Refining	Texas City, Tex.	Cat. Cracker	19,000 bbls.	$2.4 million	Under Constr.	End, 1952	Houdry	Houdry	Kaiser
Texas City Refining	Texas City, Tex.	Avia-Alkylate		$2.5 million	Certified DPA				
Texas Eastman	Longview, Tex.	Petrochemicals	20,000 bbls. Propane	$5.7 million	Partial Oper.				
Tex.-Harvey Gas	Midland, Texas	Gas Plt.; Refrig.	35 mcf wet	$5.5 million	Completing				
The Texas Co	Pt. Arthur, Tex	Expansion	20,000 bbls.		Under Constr.	1952		Texas Co.	
The Texas Company	Port Arthur	Gasoline Plt.	18,500 bbls.	$1,286,000	Approved DPA	1953			
Texas Co.	El Paso, Texas	Expan. Mod.	†5,000 bbls.		Planned	Late, 1954			
The Texas Company	Amarillo, Texas	Av-Gasol Fac.	47,000 bbls.	$20,750,000	Approved DPA	Late, 1954			
*Texas Gas Products Corporation	Rankin, Texas	Gas Plt. Expan.			Under Constr.	Early 1953		Texas Natural	Texas Natural
*Texas Natural Gasoline Corp. & H. W. Bass & Sons, Inc.	Whiteboro, Tex.	Remote Absorption Sta.	30,000 gals.		Under Constr.	Complete		Texas Natural	Texas Natural
United Carbon Co	Shamrock, Texas	Carbon Black	68,500 lbs.	$1.5 million	Under Constr.				
United Gas Pipe Line	Sterlington, La.	Dehydration	†25,000 mcf		Under Constr.				Staff
United States Rubber Co.	Baton Rouge, La.	Buna W Rubber Plt. Expan.	82,200 lbs.		Completing				
Universal Oil Products	Mooringsport, La.	Synthetic Cat. Mfg.			Announced				
*Warren Pet. Co.	Houston, Texas	Terminal Docks and Piping			Under Constr.	End 1952	Staff	Staff	Tellepsen
*West Texas Gas Co.	Fritch, Texas	Plt. Mod.		$300,000	Design	Mid-1953		Anderson-Baird	
Wickett Refining	Wickett, Texas	Thermal Crker	2,000 bbls.		Under Constr.				
ROCKY MOUNTAIN									
Bay Petroleum	Denver, Colo.	Fluid Cat. Crk.	3,500 bbls.	$1.9 million	Under Constr.	Jan., 1953	U.O.P.	Procon	Procon
Bay Petroleum	Denver, Colo.	Crude Expan.	6,000 bbls.		Under Constr.			Procon	Procon
Bureau of Mines	Rifle, Colo.	Demonst. Retort.	150-400 ton	$333,870	Completing	1952		Blaw-Knox	Staff
California Co.	Rangely, Colo.	Products Addi.		$700,000	Completed			Delta	Delta
*Carter Oil Co.	Billings, Mont.	Cat. Poly. Unit & Waste Heat Boiler Aux.	600 bbls.		Under Constr.	Early 1953	Blaw	Blaw	Blaw
Continental Oil Co.	Johnson Co. Wyoming	Gasoline Plt.			Announced				
Continental Sulphur & Phosphate Corp.	Thermopolis, Wyo.	Sulfur Extraction			Planning				Chemico
*El Paso Natural Gas Company	Blanco, N.M.	Comp., Dehyd. & Gaso. Plt.	180 MMscf		Engineering	2nd Qtr., 1953		Fluor	Staff
*El Paso Natural Gas	Gallup, N.M.	Fractionation			Engineering	2nd Qtr., 1953		Fluor	Staff
*El Paso Natural Gas Company	San Juan Co., N. M.	Gasoline Plt.	4,500 bbls.		Planned	1952		[illegible]	
*Empire Pet. Co.	Denver, Colo.	Crude Expan.	†3,500 bpd		Announced				
Farmers Union Central Exc.	Laurel, Mont.	Fluid Cat. Crker.	5,000 bbls.	$3.5 million	Under Constr.	Nov., 1952	U.O.P.	Ref. Eng.	Ref. Eng.
Garfield Chemical & Mfg. Corp.	Salt Lake City	Sulfuric Acid		$2.5 million	Plan				
Genl. Pet. Corp	Worland, Wyo.	Gasoline Ext.	8 mmcf	$4 million	Certified DPA				
Malco Refineries	Prewitt, N.M.	Expansion	†1,500 bbls.	$500,000	Completing		Atlantic	Grebe & Doremus	Grebe & Doremus
*McNutt Oil & Ref. Company	Brickland, N.M.	Platformer	600 bbls.	$300,000	Design	1953	U.O.P.	U.O.P.-Procon	Staff
Oriental Refining Co.	Denver, Colo.	Perco Cyclovertion Unit	1,500 bbls.		Under Constr.				
Phillips Chem.	Eunice, N. M.	Sulfur Extrac.	100 tons	$1.5 million	Contracted				
Phillips Petroleum	Lea Cty., N. M.	Natural Gasoline		$27,150	PAD Certified				
Phillips Petroleum Co.	Woods Cross near Salt Lake City, Utah	Vac. Plt., Gas Plt.; Storage, Cat. Crk.	6,000 bbls.	$10 million	Completing			Fluor	Fluor
Phillips Petroleum	Woods Cross, Utah	Expanded Gasoline Fac.	8,000 bbls.	$5.7 million	Completing				Fluor
Phillips Petroleum	Great Falls, Montana	Refining		$3 million	Certified DPA				
Proven Oil & Refining	Florence, Ariz.	Refinery	15,000 bbls.	$18.3 million	Planning	1955		Ebasco and Lummus	
Pure Oil	Worland, Wyo.	Sulfur Recovery	30 million		Engineering			Foster Wheeler	Tex. Gulf Sulphur
*Salt Lake Refining	Salt Lake City, Utah	Acid Treating Unit		$450,000	Design			Bechtel	Bechtel
*Sullivan Mining Co	Kellogg, Idaho	Sulfuric AcidPlt.	300 tons		Under Constr.	January, 1954		S & B	S & SB
Utah Oil Ref.	Salt Lake City	Expansion		$1 million	Under Constr.	January, 1953		CB&I	CB&I
Western States Refg.	Salt Lake City	Topping; Crker.	3,000/2,200 bbls.	$1.1 million					
WEST COAST									
*Allied Chemical & Dye Corp.	Port Chicago, Calif.	Aluminum Fluoride Plt.		$1 million	Under Constr.	Mid 1953		Bechtel	Bechtel
Caminol Co.	Hanford, Calif.	Motor Gasoline & Distillate			Announced	1953			
*Carbide & Carbon Chemicals Company	Torrance, Calif.	Polyethylene Plt.	60 million lbs./yr.	$36 million	Certified DPA				
Dow Chemical	Pittsburgh, Cal.	Methylene Chloride		$670,000	Completing				
Ethyl Corp.	Wilmington, Calif.	Gasoline Facilities		$164,125	PAD Certified				
Eureka Refining	Long Beach, Cal.	Cat. Crker.	6,000 bbls.	$2.2 million					
General Petroleum	Torrance, Calif.	De-butaniser Tower, Alkylation Re-Run		$575,000	Completing			G. P. Staff	J. B. Gill
General Petroleum	Torrance, Calif.	Therm. Cat. Reform.		$9 million	Projected		So-Vac.		
Hancock Oil Co.	Long Beach, Cal.	Ethylene Glycol	20,000 bbls.		Under Constr			Badger Div.	Badger Div.
Hancock—Calif.	Long Beach	Aviation Gaso.		$3 million	PAD Certified				
Hancock Chem.	Long Beach	Sulfur Extrac.	50 tons	$250,000	Completing			Parsons	Parsons
*International Mineral and Chemical	San Jose, Calif.	Chemical Process Plt.		$425,000	Under Constr.				Bechtel

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Mohawk Petroleum	Bakersfield, Calif.	Jet Fuel Prod.		$3 million	Announced				
Monsanto	Avon, Calif.	Sulfuric Acid	250 tons		Engineering	End 1952		Monsanto	Leonard Constr.
Navy	San Joaquin, Calif.	Natural Gas Plt.	50,000 mcf	$5 million	Under Constr.				Parsons-Maceo
Richfield Oil	Watson, Calif.	Expansion; Cat Cracker; Aromatics	30,000 bbls.	$43 million	Under Constr.	1954		Braun	Fluor
Richfield Oil	Los Angeles	Refinery Expan.	†20,000 bbls.	$40 million					Fluor
Rothschild Oil	Santa Fe Springs, Cal.	Cat. Crker.	6,000 bbls.	$2 million					Braun
Shell Chemical	Ventura, Calif.	Synthetic Ammonia Plt.	150 tons		Under Constr.	July, 1953		Kellogg	Kellogg, Gibbs & Hill
Shell Chemical	Martinez, Calif.	Sulfonates		$90,000	Under Constr.	Late, 1952		Bechtel	Bechtel
Shell Chemical	Martinez, Calif.	Distilling Expan.	15,000 bbls.	$300,000	Under Constr.	Late, 1952		Bechtel	Betchel
Shell Oil	Shell Point	Refinery	25,000-50,000 bbls.	$25 million	Planning				
Shell Oil Co.	Wilmington, Calif.	Distillation Tower	52,000 bbls.	$4.7 million	Under Constr.	Early 1954		Bechtel	Bechtel
Signal Oil & Gas	Los Angeles, Cal.	Butanes-Iso-butane		$500,000					
*Socony-Vacuum	Torrance, Calif.	T.C.R.						Fluor	Fluor
Standard (Cal.)	El Segundo	Feed Preparation	23,000 bbls.	$2.5 million	Completing		U.O.P.	U.O.P.	Procon
Standard (Cal.)	El Segundo	Platformer	10,000 bbls.	$5 million	Completing		Staff		Bechtel
Standard (Cal.)	Richmond, Calif.	Alkane Plt. Alt.	13 mln. lbs./yr.	$1.5 million	Under Constr.	Jan., 1953			
Standard (Calif.)	Richmond, Calif.	Synthetic Phenol	35 mln. lbs./yr.	$4 million	Engineering	July, 1953		Kellogg	Kellogg
Standard—Calif.	Richmond, Calif.	Vacuum Flasher	55,000 bbl.		Completed			Kellogg	Kellogg
Standard Oil-Calif.	Richmond, Calif.	Modernization			Completed		Houdry	Houdry	Betchel
Standard Oil-Calif.	Richmond, Calif.	TCC to Houdry	7,500 bbls	$9 million	Completed			Fluor	Fluor
Standard Oil of Calif.	El Segundo, Calif.	Benzene Plt.	850 bbls. Benzene, 3,200 bbls. Toluene	$2.5 million	Under Constr.	Oct., 1952			
Standard Oil of Calif.	El Segundo	Cat. Cracker	36,000 bbls.	$20 million	Projected	1954			
*Standard Oil Co.	Compton, Calif.	Sulfuric Acid		$57,070	Engineering				
Stauffer Chemical	Richmond, Cal.	Sulfuric acid		$283,500				Procon	Procon
Stauffer Chemical	Santa Maria, Cal.	Reconstruction	5,000 bbls.						
Sunray Oil	Avon, Calif.	De-ethanizer		$865,000	Under Constr.	Mid 1953		Bechtel	Bechtel
*Tide Water Assoc.	Los Angeles	T.C.C. Revision		$1.7 million	Under Constr.	Oct., 1952	Houdry	McKee	McKee
Union—Calif.	Los Angeles, Calif.	Acid Treat. & Rerun; H_2S Recovery	15,000 bbls.	$2.6 million	Completing			Braun	Braun
Union—Calif.	Los Angeles	Research Plt.		$540,000	Completing			Girdler Corp.	
Union Oil Co. of Cal.	Brea Olinda, Cal.			$5 million	Projected			Austin, Field and Fry	Walker
Union Oil	Los Angeles, Cal.	Crude Topping	40,000 bbls.	$6 million		Dec., 1952		Fluor	Fluor
Union Oil	Los Angeles	Alkylate Fac.	250 bbls.	$135,000					
Union Oil	Wilmington, Cal.	Cat. Cracker	28,500 bbls.	$4.5 million					
Union Oil	Wilmington	Av.-Gas		$135,000					
Union Oil	Oleum, Calif.	Gasoline & Fuel Expan.		$84,780	Certified DPA				
Union Oil Co.	Edmonds, Wash.	Asphalt Refinery	65,000 tons		Completing				Beehtel
*Union Oil (Calif.)	Los Angeles	Sulfur Mfg. Plt.	50 tons	$450,000	Under Constr.	Late 1952		Parsons	Parsons
*Union Oil (Calif.)	Los Angeles, Calif.	Ammonium Sulfate Plt.	50 tons	$750,000	Under Constr.	Early 1953		E&A	E&A
*Union Oil (Calif.)	Wilmington	Crude Expan.	40,000 bbls.		Under Constr.	End 1952			Braun
U. S. Navy and Standard Oil of Calif.	Elk Hills, Calif.	Nat. Gas Plt.	50 mmcf	$45 million	Completing				
FOREIGN									
Canada									
British-American	Moose Jaw, Sask.	Crude	15,000 bbls.				U.O.P.	Tears	Can. Kellogg
British-American	Moose Jaw	Thermal Crk.	1,500 bbls.	$8 million	Completing			C. W. Nofsinger	
British-American	Moose Jaw	Cat. Cracking	4,500 bbls.	$1.5 million	Engineering	Late 1952	Hercules	Can. Kellogg	Can. Kellogg
British-American Oil	Clarkson, Ont.	Grease plt.	42,000 lbs.	$3 million	Under Constr.	Oct., 1952			
British American Oil and Shawinigan Chemicals	Montreal, East	Petro Chemical Plt.—Phenol	36,000 lbs.					Staff	Stone & Webster
Cabot Carbon of Canada	Sarnia, Ont.	Carbon Black Plt.	54,000 lbs.	$1 million	Under Constr.	Jan., 1953			
*Campbell Absorption Plant, Ltd.	Alberta, Canada	Natural Gaso. Plt.			Planned				
Canadian Chemical Co.	Edmonton Area, Alberta	Petro Chemical Plt.		$50 million	Under Constr.	March, 1953		Celanese-Brown Root	Brown Root
Canadian Oil Refineries	Froomfield, Ont	Refinery	20,000 bbls.	$18 million	Under Constr	1952		Can. Kellogg	Can. Kellogg
Canadian Industries	Montreal, Quebec	Polyethylene Mfg.		$13 million	Start Spring	Late 1953			
Canadian Industries, Ltd.	Edmonton, Alta.	Polythene Plt.	16.6 tons		Announced	Late, 1953			
Dominion Tar & Chemical Co., Ltd.	Montreal East	Petro Chemical Plt.		$50 million	Design	End 1952		dadger	Badger
*Hi-Way Refineries, Ltd.	Saskatoon, Canada	Thermal Crack-Expan.	†15,00 bbls.	$0.5 million	Under Constr.	Late 1952	U.O.P.	Ref. Eng.	Ref. Eng.
*Hi-Way Refineries, Ltd.	Saskatoon, Canada	Cat. Cracker	3,000 bbls.	$2.5 million	Engineering	Late 1953	U.O.P.	Ref. Eng.	Ref. Eng.
Imperial Oil	Edmonton, Alberta	Crude Revamp	3,500 bbls.	$5.5 million	Completing			Staff	Foster Wheeler
Imperial Oil	Sarnia	Fluid Cat. Crk., Gas Recov. Plt. Vac. Dist. Unit	22,600 bbls.	$14.6 million	Under Constr.	Summer 1953		Staff	Can. Kellogg
Imperial Oil	Sarnia	Fluid Cat. Crk., Dist., Light Ends Recov	71,000 bbls.		Competing			Toronto Iron Works	Horton Steel
Imperial Oil	Sarnia	30 Storage Tanks	3 million bbls.	$13.5 million	Under Constr.	Fall 1953		Canadian Bechtel, Ltd.	Canadian Bechtel, Ltd.
Imperial Oil	Ioco, B. C.	Cat Cracker	†10,500 bbls.	$7 million	Plan	Early 1954		Staff	Fluor
Imperial Oil	Regina, Sask.	Mod. & Expan.	†2,500 bbls.	$2 million	Under Constr.			Procon	Procon
Midland Pet. & Pacific Pet.	Stettler, Alta.	Crude Refinery	4,000 bbls.		Projected				
Panther Oil and Grease Co.	Leaside, Toronto, Ontario	Grease and Compounding		$3 million	Under Constr.	Late 1952		Braun	Braun
Shell (Canada)	Montreal, East	Petro Chem Plt	50,000 lbs.		Engineering	2nd Qtr., 1954	U.O.P.	Fluor	Fluor
*Shell Oil Co. of Canada, Ltd.	Vancouver, B.C.	Refinery Expan.	15,000 bbls.	$300,000					
Shell Oil	Shellburn, Ver.	Refinery Warehouse							
Sun Oil	Sarnia, Ont.	Refinery	10,000 bbls.	$10 million	Spring, 1952	March, 1953	Houdry-Sun	Cat. Const.-Sun	Cat. Constr.
Supreme Refineries	Ogden, Alta.	Asphalt Plt.			Planning				
Tor American Oils Ltd., & Trilor Oils, Ltd.	Alberta, Canada	Refinery			Planned				

■ Continued on page 89

Licked before they start!

BLAW-KNOX FOG SYSTEMS DON'T GIVE FIRES A CHANCE TO GROW UP

Chemical and petroleum fires strike fast with little or no warning. But not so fast that a Blaw-Knox Fog System actuated by rate-of-rise thermostats can't knock 'em out with a smothering blanket of fog *before* they really get started.

A Blaw-Knox System engineered for the fire hazards existing in or around your plant is a most effective weapon against fire's toll. On the job 24 hours a day, it protects your property as well as products essential to our national economy.

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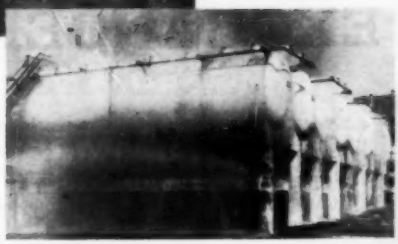

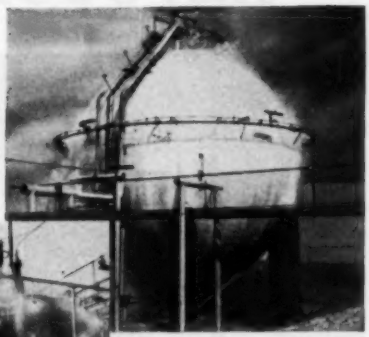

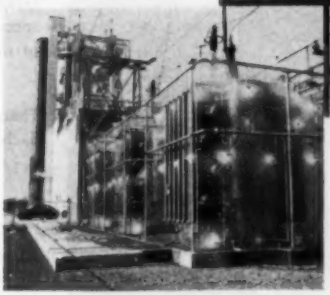

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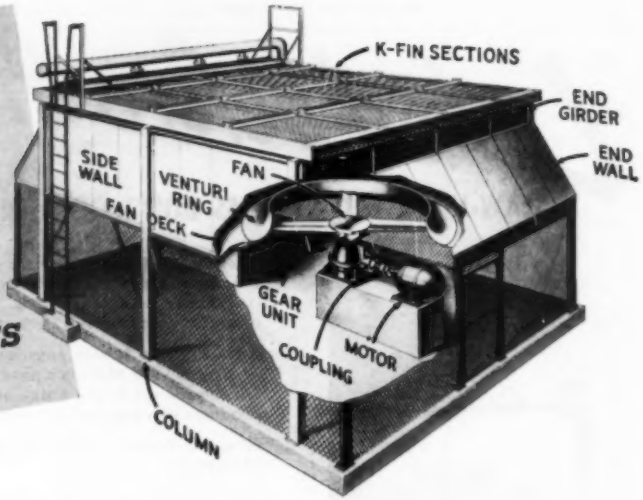

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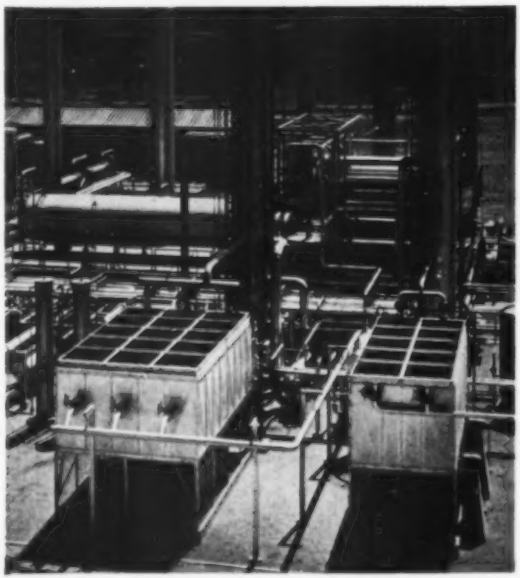

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FIN-FAN *Air-Cooled Exchanger*

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Latin America									
Brasilian Govt.	Sao Mateus (Santo) Brazil	Shale Oil Pilot Plt.	100 bpd	$500,000					Kellogg
Brasilian Investments	Niteroy, Rde J. Brazil	Refinery	20,000 bbls.		Petitioned				
Cia Industrial de Rochas Betuminosas	Between Rio-Sao Paulo, Brazil	Shale oil pilot Plt.	20 bpd		Completing				
*Colombian Petro-Company	Barco Concession	Gas Treating Plt.	1 MMcf	$5 million	Start Late 1952				
*Colombian Petroleum	Tibu Field	Refinery	2,000 bbls.		Tenders Out			Fluor	Fluor
*Colombian Petroleum	Tibu, Colombia	Gasoline Plt.	60 mmcf		Engineering	4th Qtr., 1953			
		Crude Stabilizer	10,000 bbls.						
Conselho Nacional	Bahia, Brazil	Expansion	5,000 bbls.		Under Constr.	Mid, 1953	Hydrocarbon	Kellogg \ PA Hydro Res.	Kellogg PA Hydro Res. and McKee
Conselho Nacional do Petroleo	Cubatao, Sao Paulo, Brazil	Therm. Crk. Ref. Reforming, Vis Breaking Cat. Poly	45,000 bbls.		Under Constr.				
								Kellogg	Kellogg
Conselho Nacional do Petroleo	Mataripe, Bahia, Brazil	Ref. Expn. Cat. Poly L.P.G.	2,500 bbls.	$3.5 million	Completing			Kellogg-P.A., Hydro. Res.	Staff
Conselho Nacional	Salvador, Brazil	Cat. Poly. LPG	5,000 bbls.		Under Constr.				
The Corporacion de Fomento de la Production	Concon, Valparaiso, Chile	Refinery	14,000 bbls.	$9 million	Planning	1953			
Creole Pet. Corp	El Roble Field, Venezuela	Repressuring			Planning				
Creole Petroleum	Junepin, Venezuela	Revamp Ref.	15 mmcf 450 bbls.		Under Constr.	Nov., 1952			Braun
Diadema, Argentina	Buenos Aires	Luboil Refining	600 bbls.		Projected			P.A., Kellogg	P.A., Kellogg
Empresa Nacional de Petroleo	Concon, Chile	Refinery	20,000 bbls.	$10 million	Begin 9-52			Foster Wheeler	Foster Wheeler
International Petroleum (Colombia)	Barrancabermeja, Colombia	Refinery Modernization	35,000 bbls.	$20-25 million	Under Constr.	Late 1954			Staff
Ipiranga S.A. Cia Brasilira de Petroleos	Rio Grande, Brazil	Therm. Crk. Ref. Crude Unit	2,000 bbls. 3,000 bbls.		Under Constr.	1952	Foster Wheeler		
Monsanto S.A.	Sao Paulo, Brazil	Plastics Plt.			Under Constr.	Late 1952			
Petroleos Mexicanos	Mazatlan	Refinery	15,000 bbls.	$1.7 million	Projected				
Petroleos Mexicanos	Ciudad Madero, Mexico	Desulfurization Units	12,000 bbls.	$1.5 million	Under Constr.	Dec., 1953	Perco	McKee-Phillips	McKee
Petroleos Mexicanos	Tamaulipas, Ciudad Madero Mex.	Enlarge Refinery Capacity	47,250 bbls.		Planning				
PEMEX	Guaymas, Mex.	New Refinery	10,000 bbls.	$1.3 million	Projected				
Petroleos Mexicanos	Tamaulipas, Arbol Grande Pet., Mex.	Enlarge Refinery	16,600 bbls.		Planning				
Petroleos Mexicanos	Mata Redonda, Vera Cruz, Mex.	Improvements	9,000 bbls.		Planning			McKee	McKee
PEMEX	Poza Rica, Mex.	Expansion	†100 mmcf	$3.6 million	Under Constr.	1954			
Petroleos Mexicanos	Poza Rica, Mex.	Improvements to Skimming Plant	3,100 bbls.		Planning				
Petroleos Mexicanos	Reynosa, Mex.	Expansion			Planning				
Petroleos Mexicanos	Salina Cruz, Mexico	Refinery	10,000 bbls.	$752,000	Under Constr.	1954	Texaco	McKee	McKee
Petroleos Mexicanos	Salamanca, Mex.	Lube Oil and Paraffin Plt.	2,200 bbls. Lube 143,000 lbs. Wax	$20 million		1952			
Petroleos Mexicanos	Tampico, Mex.	Modern., Sulfur Ext.		$1.5 million		1952			
Petroleos Mexicanos	Minatitlan, Mexico	Modern., Sulfur Ext.		$1.5 million				Pritchard	C. B. & I.
Phillips Oil Co	San Rogue Fld., Anacotegui, Venezuela	Refinery, Wax Plt.	5 mln. lbs. wax/year		Completed			Staff	CB&I
Phillips	San Rogue Fld., Anacotegui, Venezuela	Crude Stab. and Pressure Maint. Plt.	10,000 bbls. and 38 mmcf		Completed			Staff	CB&I Kellogg
Phillips	San Rogue	Crude Distill.	5,000 bbls.						
Private Group	Rio de Janeiro	Refinery	20,000 bbls.		Projected		Undetermined	Parsons, Brinckerhoff, Hall and Macdonald	
Puerto Rican Oil Refining Co.	Near Ponce, Puerto Rico	Refinery	25,000 bbls.	$20 million					
Refinaria de Petroleo do Distrieto Federal S.A.	Manguinhos, Brazil	Refinery	10,000 bbls.	$10 million	Completing				
Refinaria de Petroleos	Rio de Janeiro	Therm. Crk.	10,000 bbls.		Authorized			Foster Wheeler	Foster Wheeler
Refinaria e Exploracao de Petroleo Uniso S.A.	Capuava, Sao Paulo, Brazil	Therm. Crk. Ref. Rec. Cat. Poly.	30,000 bbls.	$16.5 million	Under Constr.	End 1952	So-Vac.	P.A. Hydro. Res.	P. A. Hydro. Res.
Reunidas F Materazzo	Sao Paulo, Brazil	Contact Sulfur Acid Plt.	60 tons		Ordered				Chemico
Richmond Exploration Co	Bajo Grande, Venezuela	New Refinery	35,000 bbls.		Referred				
Shell Co. of Venezuela	Cardon, Ven.	Comprehensive Refg.	115,000 bbls.		Under Constr.	Early 1953			
*Shell Oil Company	Cardon	Lubricating Oil	275 tons					H.W.P.	H.W.P.
Trinidad Leaseholds, Ltd.	Trinidad	Refinery addition		$300,000	Designing				
Europe and Africa									
*Albanian Govt.	Valona, Albania	Refinery			Under Constr.	End 1952	Houdry	H. W. P.	
*Albatron S.A. Pour le Raffinagede Petrol	Antwerp, Belgium	Houdriflow Cat. Cat. Cracker	3,800 bbls.		Engineering				
AIOC	Aden, England	New Refinery	120,000 bbls.	$100 million	Design	1954		Middle East, Bechtel	Middle East, Bechtel
						End 1952			
AIOC	Nuehof, Germany	Refinery Expan.	2,000 bbls.	$2.8 million					
Anglo Iranian	Kent, England	Expansion	80,000 bbls.		Under Constr.	1953		Badger Div., Lummus, Kellogg	Badger Div., Lummus, Kellogg
Anglo-Iranian Oil	Isle of Grain, Eng.	New Refinery	40,000 bbls		Under Constr.	End, 1952			
					Contracted	60,000—1952		Badger Div.	Badger Div.
Anglo-Iranian Oil	Kent, Eng.	Atomspheric Distill.	80,000 bbls.			80,000—1953			
Anglo-Iranian Oil	Kent, England	Vacuum Distill.	2 x 17,000 bbls.		Contracted	Mid 53 Fall 53		Badger Div.	Badger Div.
Anglo-Iranian Oil	Kent, England	Rerun Unit	2,400 bbls.		Under Constr.				
Anglo-Iranian Oil	Kent, England	Solutiner	5,400 bbls.		Under Constr.				
Anglo-Iranian Oil	Kent, England	Cu Chloride Treating	4 x 8,000 bbls.		Under Constr.				

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Anglo-Iranian Oil	Kent, England	Acid/Soda Treat.	2,000 bbls.		Under Constr.				
Anglo-Iranian Oil	Kent, England	Propane Deasph.			Under Constr.			Kellogg	Kellogg
Anglo-Iranian Oil	Kent, England	Furfural Extrac.	2,800 bbls.		Under Constr.	Fall	Texaco	Lummus	Lummus
Anglo-Iranian Oil	Kent, England	MEK Dewaxing			Under Constr.	1953	Texaco	Foster Wheeler	Foster Wheeler
Anglo-Iranian Oil	Kent, England	Clay Contact			Under Constr.			Lummus	Lummus
Anglo-Iranian Oil	Kent, England	Fluid Cat. Crk.	10,000 bbls.		Under Constr.	Mid 1953		Kellogg	Kellogg
*AIOC	Antwerp, Belgium	Cat. Cracking Plt.			Planned				
Anglo-Transvaal Consolidated Investment Co.	Vall River, Union of South Africa	Synthetic Gasoline and Diesel Oil Plt.		$50-60 million	Contracted			Hydro. Res.	
Aquila, S.A.	Trieste, Italy	Prop. Deasph., Furf. Sol. Ref. MEK Dewax. Contact Filte Dist. & Blend.	109 tons 95 U1 Lubes & Bright Stocks 8 tons all Paraffin Waxes	$7.9 million	Under Constr.		Juik, Texaco	Badger Div.	Badger Div.
Aquila, S.A.	Trieste, Italy	Lube Oil Ref.	800 bbls.	$7.9 million	Completing		Juik, Texaco	Badger Div.	Badger Div.
*Atlantique Progil-Electro-Chemie	Dorgen, France	Cumene Plt.	326 bbls.		Engineering	1953	Hydrocarbon	Hydrocarbon	Hydrocarbon,
Batsafsche Petroleum Maatschappij	Pernis, Holland	Expansion	165,700 bbls.		Projected	Late, 1953			
Benzene & Pet. Co. of Hamburg	Hamburg-Finkenwerder, Germany	Expansion	660,000 bbls.		Announced				
William Briggs & Sons, Ltd.	Camperdown, Scotland	Crude Dist. Plt.	1,000 bbls.		Completing				
California-Texas Oil Co.	Pernis, Netherlands	Expanding Refinery	28,000 bbls.		Under Constr.	Early 1953		Various Local	Various Local
Cie de Raffinage Shell-Berre	Berre, France	Expansion	65,000 bbls.	$31.6 million	Under Constr.	End 1953			
Cie de Raff Shell-Berre	Pauillac, France	Distilling Expansion	10,800 bbls.		Under Constr.	Late 1952			
Cie Francaise de Raffinage	La Mede, France	Cat. Crk., Gas Recov. System	11,500 bbls.	$2 million	Authorized	April, 1953	SOD	SOD, Lummus	Lummus
Cie. Francaise	Gonfreville	Gas Recov.			Completed	1952	Texaco & Juik	Kellogg	Local
Cie. Francaise de Raffinage	Gonfreville, France	Therm. Reform., Prop. Deasp., Furfl. Trtng.	4,750 bbls.	$11 million					
Compania Espagnole de Petroles, S.A.	Santa Cruz de Tenerife	Reforming Unit	5,000 bbls.	$1 million	Planned		U.O.P.	U.O.P.	Foster Wheeler
Condor, S.P.A. Per l'Industriale Pri. Chemica	Rho, Italy	New Refinery	27,000 bbls.		Under Constr.	1952		Badger Div.	Badger Div.
		Cat. Cracker	115,000 bbls.		Under Constr.	1953	So-Vac.	Badger Div.	Badger Div.
Condor	Rho, Italy	Atm. Dist. Plt.	30,000 bbls.		Under Constr.	1953	So-Vac.	Badger Div.	Badger Div.
Condor	Rho, Italy	Feed Prep., TCC Unit	15,000 bbls.		Under Constr.	1953	So-Vac.	Badger Div.	Badger Div.
			10,000 bbls.		Under Constr.		Socony-Vac.	Badger Div.	Badger Div.
Condor	Rho, Italy	Recov. Purification Plt., Adm. Bldg., Pwr House			Under Constr.	1953		Badger Div.	Badger Div.
Joseph Cromfield & Sons, Ltd.	Warrington, England	Catalyst Plt.		$3 million	Under Constr.	End, 1952	Davison Chem.	Badger	Badger
Deutsche-Amerikanische Petro-Gesellschaft (Esso)	Hamburg-Harburg, Germany	Cracking Plt. and Expansion	8,843 bbls.	$10 million	Under Constr.	Jan., 1954		S.O.D.	Gutte-Hutte
Deutsche Erdoel, A. G.	Heide, Germany	Cracking Fac. Cat. Poly.	12,800 bbls. Gas 11,250 bbls. Diese		Under Constr.	Late, 1952	Socony-Vac., Hydrocarbon	Hydrocarbon	Hydrocarbon, Staff
*Deutsche Erdol-Aktiengellschaft-DEA	Heide, Germany	Dewaxing	211 tons		Engineering	1953	Edeleanu	Edeleanu	Edeleanu-Staff
Deutsche Vacuum Oel A.G.	Hamburg, Germany	Cracking Unit	8,000 bbls.		Under Constr.	1952		Socony-Vac	Gutte-Hutte
Egyptian Government	Cairo, Egypt	Crude Plt.						Lummus	Lummus
Egyptain Government	Suez, Egypt	Ins. Refn. Cap.	26,000 bbls.	$2,500,000	Planning				Lummus
Empresa Nacional	Puertollano, Spain	Shale Oil Ref.	3,000 bbls.		Under Constr.	1952			
Esso Stand. Hatenas.	Genoa, Italy	Cap. Increase						S.O.D.	Lummus
Esso Standard Refg.	Antwerp, Belg.	New Refinery Inst. Crkg.	25,000 bbls.		Under Constr.	July, 1953			
*Gelsenberg Benzin Aktiengewellschaft	Gilsenkirchen, Germany	T. C. C. Unit	30,000 bbls.		Under Constr.	Late 1952	Soc-Vac, Hydrocarbon	Hydrocarbon	Hydrocarbon, Staff
*Gewerkschaft Deutche Erdoel-Raffineries Deurog.	Marburg, Germany	Cat. Poly.	220 bbls.		Under Constr.	1953	Hydrocarbon	Hydrocarbon	Hydrocarbon, Staff
Garrace	Genoa, Italy	Cap. Increase						Lummus	Lummus
Gewerkschaft Erdoel-Raffinerie Emsland	Near Lingen, Germany	Refinery Houdry Cat.	11,535 bbls. 7,000 bbls.	$8,670,000	Under Constr.	4th Qtr., 1952	Houdry	Lummus	Lummus
Industrie Chimiche Italiane Petrol.	Mantua, Italy	Crude Ref.	4,500 bbls.		Contracted	1952		Koch	Craig
Industria Petrolifera Chimica	Milan, Italy	Gasoline Fuel Oil Plt.	20,000 bbls.					Dr. Calogero Inglogio	
Industria Raffinazione Oli Minerali (IROM)	Porto Marghera, Italy	Cat. Cracking Atmos. Distill. Thermal Ref.	1,400 bbls. 12,000 bbls. 6,000 bbls.	$2 million	Under Constr.			Foster Wheeler	Kellogg
					Under Constr.			Kellogg	Kellogg
Imperial Chemical Industries, Ltd.	Wilton, Yorkshire, England	Petroleum Cracking Unit	2,000 bbls.		Completing		Phillips	Koch	Staff
I. P. S. A.	Rotkreuz, Switz.	Cat. Reformer	700 bbls.		Licensed		So-Vac.		
Kali Chemie Co.	Nienberg, Germany	Bead Catalyst Plt.			Under Constr.	Early 1953			Am. Cyanamid
Ketjen	Amsterdam, Netherlands	Synthetic Catalyst & Mfg.			Projected				
Manchester Oil Refinery, Ltd.	Partington, England	New Lube Refinery	30,000 bbls.		Under Constr.	End 1952			
Manchester Oil Refinery	Trafford Park, Eng.	Expansion							
Mineralol-und Asphaltwerke, A.G.	Ostermoor, Germany	Reconstruction	1,196 bbls.						
Monsanto Chemical Co.	Britain	Add Polystyrene			Under Constr.			Staff	Staff
Montecatini Co.	Ferrara, Italy	Olefin Plt.	450 bbls.	$18.6 million	Contracted	Mid 1953		Kellogg	Kellogg
A. P. Moeller	Copenhagen, Denmark	Thermal Cracking Plt.	2,000 bbls.	$3.5 million	Field work				
National Oil Refineries, Ltd.	Llandarcy, Wales	Vacuum Unit	17,000 bbls.		Under Constr.			Badger Div.	Badger Div.
N.O.R.	Llandarcy	Propane Deasphalting	3,500 bbls.		Under Constr.	End, 1952	J.U.I.K.	Badger Div.	Badger Div.
N.O.R.	Llandarcy	Furf. Ext.	1,250 bbls.		Under Constr.	End, 1952	Texaco	Badger Div.	Badger Div.
N.O.R.	Llandarcy	M.E.K. Dewaxing	1,700 bbls		Under Constr.	End, 1952	Texaco	Badger Div.	Badger Div.
N.O.R.	Llandarcy	SO2 Kerosene Ext.	3,000 bbls		Under Constr			H.W.P.	Staff
National Oil	Llandarcy,	Boilers Add.			Under Constr.	1952		Ewbank & Partners	

• Continued on page 93

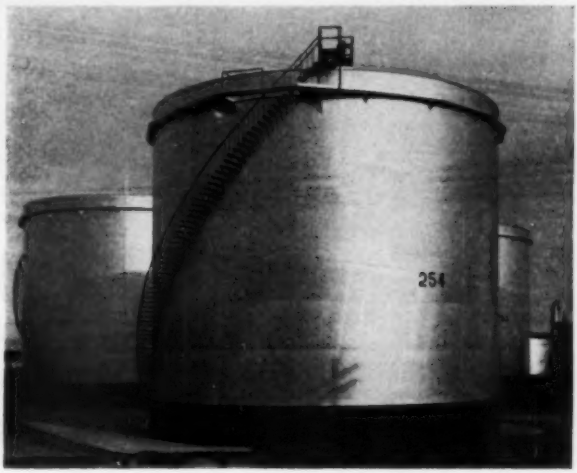
Bakersfield Refinery uses Horton Floating Roofs

FOUR years ago the Standard Oil Company of California began to modernize and expand its Bakersfield, California refinery. They planned to increase capacity 50 per cent and improve the quality of the refined products. Today the modernized and improved refinery, back on stream since August, 1949, has thirty new tanks with Horton Floating Roofs that are efficiently and economically handling and storing its increased output.

Throughout the petroleum industry today, modern storage tanks equipped with Horton Floating Roofs are reducing evaporation loss, corrosion, and fire hazard. These roofs float directly on the surface of the liquid. The entire bottom of the roof is normally in contact with the liquid in the tank. There is no air-vapor mixture above the liquid that can be vented and lost. Fire hazard and corrosion are reduced as a result of the elimination of this vapor space.

Another feature of the Horton Floating Roofs that assure superior protection against evaporation is the Horton Seal. This proven device efficiently closes the space between the roof and shell of the tank.

Horton Floating Roofs are built in three types, Double-Deck, Pontoon, and Pan. Bulletin B will help you select the roof most suitable for your operation. Write our nearest office for a copy today.



Top: Panoramic view of Standard Oil Company's Bakersfield refinery showing tanks with Horton Floating Roofs in the foreground.

Above: Close-up view of three 25,000-bbl. tanks with Horton Floating Roofs used to store gasoline at Standard Oil Company of California's Bakersfield refinery.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta 3	2146 Healey Building	Detroit 26	1520 Lafayette Building	Philadelphia 3	1608—1700 Walnut Street Building
Birmingham 1	1548 North Fiftieth Street	Havana	402 Abreu Building	San Francisco 4	1551—200 Bush Street
Boston 10	1030—201 Devonshire Street	Houston 2	2126 C & I Life Building	Seattle 1	1331 Henry Building
Chicago 4	2463 McCormick Building	Los Angeles 17	1534 General Petroleum Building	Tulsa 3	1626 Hunt Building
Cleveland 15	2234 Guildhall Building	New York 6	3302—165 Broadway Building	Washington 6, D. C.	1128 Cafritz Building

REPRESENTATIVES AND LICENSEES

Ateliers et Chantiers de la Seine Maritime, Paris, France
Compagnia Tecnia Industrie Petroli, Rome, Italy
Constructions Metalliques de Provence, Arles-sur-Rhone, France
Chicago Bridge & Iron Company, Ltd., Apartado 1348, Caracas, Venezuela
Sociedade Chibridge de Construcoes Ltda., Av. Franklin Roosevelt, 194-S/704-C, Rio de Janeiro, Brazil
Horton Steel Works, Limited, Fort Erie, Ontario, Canada
Motherwell Bridge & Engineering Company, Limited, Motherwell, Scotland
Whessoe, Limited, Darlington, England
Comprimo N. V., 21, Amstel, Amsterdam (C) Netherlands

Try ORBIT FORGED STEEL LP-GAS VALVES in your refinery where liquefied refinery gas is processed, stored and shipped. Orbit's welded bonnet construction, friction free seating principle and plastic packed stem make up a modern streamlined valve that is designed to match your modern processing techniques. Orbit offers very low maintenance costs and the maximum in safety.

Orbit Forged Steel LP-Gas Valves are offered in sizes beginning with 1" up to and including 4", ASA Class, Series 150 Lb. to 2500 Lb., 250° Fahrenheit maximum working temperature, carbon trim and stainless steel trim.

–Sold by Supply Stores–

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Houston, Texas
407 Velasco
(Serving the Gulf Coast)

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402 West County Road
(Serving West Texas)

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1323 East "C" Street
(Serving the Rocky Mountain States and Canada)

ORBIT VALVE CO.

P. O. BOX 699 TULSA, OKLAHOMA

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

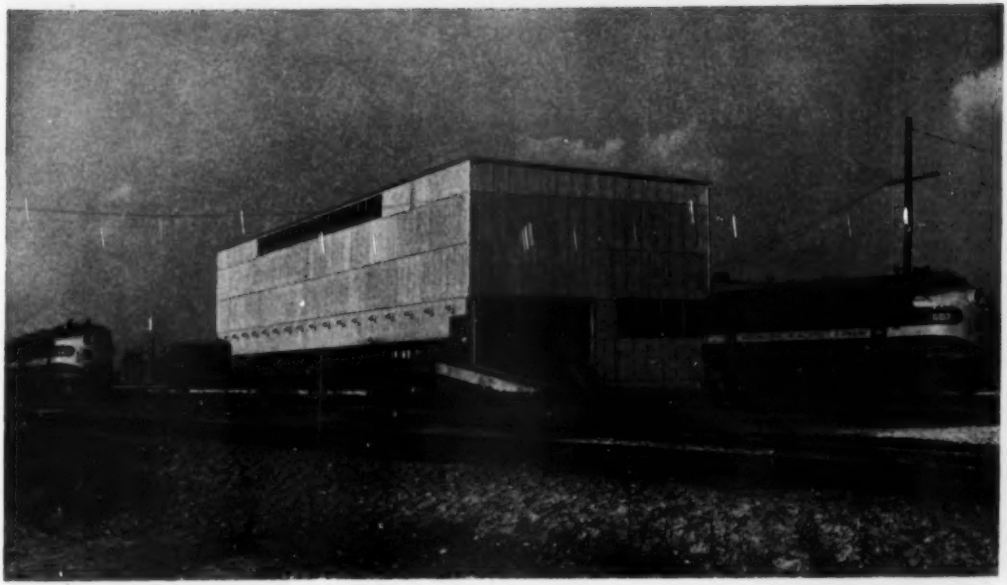
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
N.O.R.	Llandarcy	Generating Plant	12,000 KW	.....	Authorized	1952	.....	Ewbank & Partners	.....
N.O.R.	Llandarcy	Cat. Crk.	10,000 bbls.	$43 million	Under Constr.	Early 1953	J.U.I.K.	Badger	Badger
A/S Norsk Amerikansk Mineraloljekompagni	Vallo, near Tonsberg, Norway	Lube Oil, Asphalt	1,000 bbls.	.....					
Pechelbronn, S.A. E. M.	Merkwiller, France	Capacity Increase	1,550 bbls.	.....	Authorized	.....	.....	.....	.....
Permolio, S.P.A., Raffinerie Italiane Olii Minerali	Genoa, Italy	TCC Unit	2,000 bbls.	$1.4 million	Completed	.....	Socony-Vac.	Foster Wheeler	Foster Wheeler
Permolio, S.P.A.	Milan, Italy	Perco Reforming Unit	350 bbls.	.....	Under Constr.	Oct., 1952	Phillips	Staff	.....
Permolio	Genoa, Italy	Cap. Increase	.....	.....	.....	.....	.....	.....	.....
Permolio, S.P.A.	Rome, Italy	TCC Unit	2,000 bbls.	$1.4 million	Completed	.....	Socony-Vac.	Foster Wheeler	Foster Wheeler
Permolio	Milan, Italy	Furf. Sol. Ref.	.....	.....	Under Constr.	1952	Texaco	Foster Wheeler	Foster Wheeler
Permolio	Milan, Italy	Prop. Deasph.	15,000 tons/yr.	.....	Under Constr.	1952	Standard	Foster Wheeler	Foster Wheeler
Permolio	Milan, Italy	MEK Dewax.	.....	.....	Under Constr.	1952	Texaco	Foster Wheeler	Foster Wheeler
Petrochemicals, Ltd.	Partington, England	Petrochemicals	2,000 bbls.	$16 million	Under Constr.	.....	Petrocarbon	Petrocarbon	Petrocarbon
Raffineries Francaises de Petrole de l'Atlantique	St. Nazaire, France	Consolidate Refineries	7,100 bbls.	$9.4 million	.....	.....	.....	Separator-Nobel	.....
Raffineries Francaises	Paris	Thermal Reformer	4,500 bbls.	.....	Completing	.....	.....	Koch	Koch
*Raffineries Francaises	Donges, France	T. C. C. Unit	10,000 bbls.	.....	Under Constr.	.....	Soc-Vac.	Hydrocarbon	Hydrocarbon
Raffinerie Siciliane Olii Minerali, Sp.A.	Augusta, Sicily	Crude Refinery	10,000 bbls.	.....	Under Constr.	.....	U.O.P.	U.O.P., Delta, Staff, Separator-Nobel	Staff
Refineria de Petroleos de Escombreras, SA., (REPESA)	Escombreras Spain	Four cell induced draft cooling tower	.....	.....	Under Contract	.....	.....	.....	Foster Wheeler
REPESA	Escombreras, Spain	Crude Dist.	23,000 bbls.	$20 million	Completing	.....	.....	Foster Wheeler	Foster Wheeler
REPESA	Escombreras	Thermal Reformer: Poly Cat.	8,200 bbls.	$2 million	Contracted	Fall, 1952	U.O.P.	McKee	Staff
Ruhrchemie, A.G.	Oberhausen-Holten, Germ.	Crude Refinery	6,000 bbls.	.....	Completing	.....	.....	Koch	Koch
S.A. Cone. Ref. Petrem Portugal	Cabo Ruivo Plt., Portugal	Topping Unit	29,000 bbls.	.....	.....	.....	.....	Koch	Koch
S.A. Cone. Ref. Pet.	Cabo Ruivo Plt.	Cracking Unit	5,000 bbls.	.....	.....	.....	So-Vac.	Hydro-Res.	Hydro-Res.
S.A. Cone. Ref. Pet.	Cabo Ruivo Plt.	Reformer	2,500 bbls.	.....	.....	.....	.....	.....	.....
Scottish Oils	Grangemouth, Scotland	Stage II: Cat. Crk., Gas Rec. Vac. Distill., Cat. Poly Plt., & Trting. Plt.	37,700 bbls.	$52 million	Completing	.....	U.O.P.	Kellogg	Kellogg
Shell Chemical Mfg. Co., Ltd.	Stanlow, Eng.	Teepol Plant Extension	75,000 tons per year	.....	Completing	.....	.....	.....	.....
*Shell Oil Company	Rotterdam, Holland	Distillation Plt.	13.2 million tons	$5.6 million	.....	.....	.....	.....	.....
Shell Refining & Marketing Co., Ltd.	Shell Haven, England	Reforming Unit	†10,000 bbls.	.....	Completing	.....	.....	.....	.....
Shell R. & M.	Shell Haven	Feed Prep.	†16,000 bbls.	$34 million	Completing	.....	.....	.....	.....
Shell R. & M.	Stanlow, Eng.	Comprehensive Refining	85,000 bbls.	.....	Completing	.....	.....	.....	.....
Societe General des Huiles de Petrole	Dunkirk, France	Reconstruction of Refinery	36,000 bbls.	.....	Commissioned	.....	.....	Lummus	Lummus
		Lube Oil Plt.	.....	.....	Commissioned	.....	.....	Kellogg	Kellogg
*Sociedade Anonima Concessionaria em Portugal	Cabo Ruivo, Portugal	T.C.C., Gas Rec. Cat. Poly., Vac. Dist., Sweetening	11,000 bbls.	.....	Under Constr.	1953	Soc.-Vac.	Hydrocarbon	Hydrocarbon, Staff
*Sociedade Anonima Concessionaria da Rafinacao de Petroleos em Portugal	Cabo Ruivo, Portugal	Kerosine Diesel & Lube Extrac.	6,600 bbls.	.....	Engineering	1954	Edeleanu	Edeleanu	.....
*Societe Cherihenne des Petroles	Petitjean, Morocco	Feed Prep., T. C. C., Recov.	2,700 bbls.	.....	Engineering	1954	Soc-Vac.	Hydrocarbon	Hydrocarbon
Soc. Raff Petrole Gironde	d'Ambes, France	Capacity Expan.	16,500 bbls.	.....	Completing	.....	.....	.....	.....
Societe Industrielle Belgedes Petroles	Antwerp, Belgium	Crude Unit, visbreake, Thermal Cracker & Reformer	30,000 bbls.	.....	Commissioned	.....	.....	Kellogg	Kellogg
Societa per l'Industria del Petrolio	La Spezia, Italy	Expansion	30,000 bbls.	.....	Under Constr.	Early 1953	.....	.....	.....
Societa per Azional Raffineria Padana Olii Minerali	Milan, Italy	Refinery	10,000 bbls.	$20 million	Under Constr.	.....	Texaco	Foster Wheeler	.....
Societe per Azioni Raffineria Padana Olii Minerali	San Martino di Trecate, Italy	Refinery	13,300 bbls.	$15 million	Completing	.....	.....	Badger Div.	Badger Div.
Societe Raffinazione Olii Minerali (IROM)	Porto Marghera, Italy	Atmospheric & Vac. Distill., Acid Treat., Contract Filtration for Lube Oils, Electric Gen. Unit, Load Facilities	11,600 bbls.	$8.4 million	Contracted	.....	.....	.....	.....
Socony-Vacuum Francaise	Notre Dame de Gravenchon	MEK Unit	1,000 bbls.	$6 million	Under Constr.	.....	Texaco	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon	Grease and Compounding	900 lbs.	.....	Under Constr.	.....	.....	Staff	Staff
Socony-Vacuum Italiana, S.P.A.	Naples, Italy	Expansion	.....	$724,000	Design	Mid 1953	.....	Bechtel	Staff
South Africa Coal Oil & Gas	Coalbrook, Orange Free St.	Plant	3,500 bbls.	$30.4 million	Under Constr.	1953	.....	Kellogg	Kellogg
Stanic Industria Petrolifera	Leghorn, Italy	Ref. Expan.	15,500 bbls.	.....	Under Constr.	Mid 1953	.....	Staff	Staff
Standard Francaise des Petroles	Fort Jerome, France	Coal Synthesis Cat. Crk and Modernization	46,400 bbls.	$10 million	Under Constr.	June, 1953	.....	S.O.D.	Foster Wheeler
Standard Oil (N.J.)	Belgium	Dist. Crack	33,000 bbls.	.....	Completing	.....	.....	.....	.....
Standard (N.J.)	Hamburg, Germany	General Expan.	32,000 bbls.	$10 million	Plan	Jan., 1954	.....	S.O.D.	Gutehoffnung-Schutte
Standard-Vacuum Ref. of South Africa	Wentworth, Durban, Union of S. Africa	Refinery	15,000 bbls.	$17 million	Under Constr.	Late 1953	.....	Foster Wheeler	Foster Wheeler

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

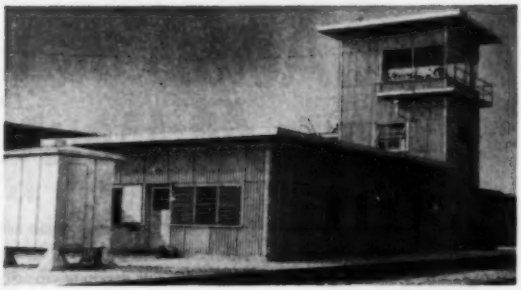
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Trent Oil Prod. Development Co.	North Shields, England	Crude Plant	11,500 bbls.	$4.8 million	Plans approved	.....	.....	.....	.....
Union Petrol Refinery, Ltd.	Johannesburg, Union of South Africa	New Refinery	.....	$30 million	Projected	.....	.....	.....	.....
*Union Rheinische Braunkohlen-Kraftstoff, A.G.	Wesseling, Germany	Dist. Ther. Crk., Reform., Cat. Cat. Poly.	8,250 bbls.	.....	Under Constr.	Late 1952	Hydrocarbon	Hydrocarbon	Hydrocarbon
Unknown	Algiers, Algeria	Refinery	1,400 bbls.	.....	Under Constr.	.....	.....	.....	.....
Vacuum Oil Co., Ltd.	London, Eng.	Oil Refinery	6.3 mln. bbls./yr.	$28 million	Planning	.....	.....	.....	.....
Vacuum Oil Co., Ltd.	Birkenhead, England	Grease Plt.	.....	$1 million	Completing	.....	.....	H.W.P.	H.W.P.
Vacuum Oil Co.	Coryton, Eng.	Lube Refinery	17,000 bbls.	$30 million	Under Constr.	Jan., 1953	Texaco	Lummus	Foster Wheeler
Near East									
Anglo-Iranian	Aden, Saudi Arabia	New Refinery	103,000 bbls.	.....	Projected	.....	.....	.....	.....
Bahrein Pet.	Bahrein	Modern. Fluid	26,000 bbls.	.....	Under Constr.	Early 1953	.....	.....	.....
Caltex	Sidon, Lebanon	Diesel, Fuel Oil	13,000 bbls.	$5.8 million	Plan	Fall, 1953	.....	Badger Div.	Staff
Consolidated Ref., Ltd.	Haifa, Palestine	Gen. Facilities Conversion of Kellogg Comb-Top. and Crk.	35,000 bbls.	.....	Planned	.....	.....	.....	.....
Iraq Government	Baghdad Area	Refinery	24,000 bbls.	$25.2 million	Contracted	Spring, 1954	.....	Kellogg	Kellogg
Israeli Government	Haifa, Palestine	Petro Chem Plt.	10 tons	$2.5 million	Under Constr.	.....	.....	.....	Staff
Turkey Government	Ramanding Field	Refinery	3,000 bbls.	$6.5 million	Planning	.....	.....	.....	.....
Far East									
*Arabian American Oil Company	Abqaiq, Saudi Arabia	Gas Injection Plt.	150 to 180 MMscf	.....	Under Constr.	3rd Qtr., 1953	.....	Fluor	Middle-East, Fluor, S.A.
Bataafsche Pet. Mij. (Shell)	Balikpapan, Borneo, East Indies	Expansion	44,000 bbls.	.....	Under Constr.	Early, 1955	.....	.....	.....
Bataafsche Pet. Mij.	Pindjor, Sumatra	Rehad. to Comprehensive Refg.	71,000 bbls.	.....	Completing	.....	.....	.....	.....
Bataafsche Pet. Mij.	Tjepu, Java	Rebuild TEL Blending Unit & Dist. Unit	.....	.....	Planning	.....	.....	.....	.....
Burmah Oil (Rangoon)	Chaukfield, Burma	2 Stage Distillation	3,000 bbls.	Salvage	Under Constr.	Dec., 1952	.....	Staff	Staff
Burmah Shell	Bombay, India	Refinery	20,000 bbls.	$47 million	Under Constr	1956	.....	.....	.....
Caltex	India	.....	20,000 bbls.	.....	Plan	.....	.....	.....	.....
Caltex	Vizagapatam, India	Refinery	.....	.....	Expected	.....	.....	.....	.....
N. V. Curracaosche Petroleum	Curacao Netherlands, Antilles	Lube Ref. Ext.	2,000 bbls.	.....	Under Constr.	Early 1954	.....	.....	.....
KOA Oil Co., Ltd. (and)	Marifu, Japan	Expansion of Vac. Unit, Contact Rerun Unit	Restricted to 3,000 BPCD	.....	Complete	.....	.....	Tatsumi	Tatsumi
Caltex Oil Co., Ltd.	India	2 Coal Hydrogenation Plts.	70,000 tons	.....	Announced	.....	.....	.....	.....
Koppers Co.	India	Modern Plt.	10,000 bbls.	.....	Complete	.....	.....	Chiyoda and Tatsumi	Chiyoda and Tatsumi
Kos Oil Co., Ltd.	Marifu, Japan	Plat. Unit	1,300 bbls.	.....	Engineering	Oct., 1953	.....	.....	.....
Mitsubishi Oil Co., Ltd.	Tokyo, Japan	Vacuum Distillation Unit	2,000 bbls.	.....	.....	.....	.....	.....	.....
Mitsubishi Oil	Tokyo, Japan	Solvent Extraction & Dewaxing Processes	.....	.....	.....	.....	.....	.....	.....
Nippon Oil Co., Ltd.	Yokohama, Japan	Modern. and Expansion	12,000 bbls.	.....	Under Constr.	July, 1954	.....	.....	.....
Nippon Oil	Kudamatsu, Japan	Modern. Plat. Unit	7,000 bbls. 1,300 bbls.	.....	Under Constr. Engineering Under Constr.	End 1952 Oct., 1953	.....	Separator-Nobel	.....
Nippon Oil	Japan	Lube Oil Refining	.....	.....	.....	.....	.....	Staff	Lummus
Standard-Vacuum	Bombay, India	Refinery	25,000 bbls.	$35 million	Under Constr.	1956	.....	.....	.....
Stan-Vac	Bombay, India	.....	20,000 bbls.	$35 million	Plan	.....	.....	Braun	Braun
*Standard-Vacuum	Melbourne, Australia	Refinery	.....	.....	.....	.....	.....	S.O.D.-Staff	Staff
Toa Nenryo Kogyo K. K.	Wakayama, Japan	Propane, Dewaxing	1,300 bbls.	.....	Completing	.....	.....	S.O.D.-Staff	Staff
T. N. K.	Wakayama	Phenol Ext.	1,720 bbls.	.....	Completing	.....	.....	.....	.....
Oceania									
AIOC	Fremantle, Australia	Refinery	70,000 bbls.	$90 million	Planned	.....	.....	.....	.....
Anglo-Iranian	Victoria, Australia	Refinery or Expansion	55-85,000 bbls.	$68-90 million	Considering	.....	.....	.....	.....
Australian Shell	Clyde, New South Wales	LVI Lube Oil	250 bbls.	$630,000	Under Constr.	Early, 1953	.....	.....	.....
Australian Shell Oil	Geelong	New Refinery	26,000 bbls.	$12 million	Under Consid.	Late 1954	.....	.....	.....
Australian Shell	Geelong, Victoria, Australia	Bitumen and Luboil Plant	.....	$10 million	Projected	Late 1953	.....	.....	.....
Australian Shell	Geelong, Victoria, Australia	Asphalt, Lube Sol. Extct Plt.	.....	.....	Projected	Late 1953	.....	.....	.....
Australian Shell	Melbourne, Australia	New Refinery	22,000 bbls.	.....	Under Constr.	Fall, 1953	.....	.....	.....
Caltex	Sydney, Australia	Refinery	22,000 bbls.	$56 million	Engineering	Jan., 1955	.....	.....	.....
Caltex	Manila, P.I.	Refinery	13,000 bbls.	$30 million	Engineering	July, 1954	.....	Braun	Braun
Vacuum Oil Co.	Altona, Aust.	Refinery	20,000 bbls.	$30 million	Engineering	1955	.....	.....	.....

* First appearince in tabulation. † Added capacity.

NOTE: Atlantic—Atlantic Ref. Co. Austin—Austin Co. Badger Div.—Stone & Webster Engineering Co. Bechtel—Bechtel Corp. Blaw—Blaw-Knox Construction Co. Braun—C. F. Braun Co. Brown & Root—Brown & Root Construction Co. Can. Kellogg—Canadian Kellogg Co. Cat. Constr.—Catalytic Construction Co. Chemico—Chemical Construction Co. C. B. & I.—Chicago Bridge & Iron Works Company Chiyoda—Chiyoda Chemical Engineering & Construction Co., Ltd. Consd. Eng.—Consolidated Engineering Company Craig—A. F. Craig & Co. D & Z—Day & Zimmerman Delta—Delta Engineering Corp. Dresser—Dresser Engineering Corp. Ebasco—Ebasco Services, Inc. E&A—Ehrhart & Arthur, Inc. Edeleanu—Edeleanu Gesellschaft M. B. H. Ferguson—H. K. Ferguson Co. Fluor—Fluor Corp. Gas Plant Constr.—Gasoline Plant Construction Corporation Graff—Graff Engineering & Equipment Gutte-Hutte—Gutte Hatnungs Hutte Hercules—Hercules Powder Co. Hudson—Hudson Engineering Corp. H. W. P.—Head Wrightson Process, Ltd. Hydrocarbon—Hydrocarbon Research, Inc. Hydro M—Hydrocarbon Mineraloel G.m.b.H. Hydro E—Hydrocarbon Engineering S.A.R.L. Kellogg—The M. W. Kellogg Co. Kellogg—P.A.—Kellogg Pan-American Koch—Koch Engineering Company Koppers—Koppers Co., Inc. Lummus—The Lummus Co. Macco—Macco Corp. McKee—Arthur G. McKee Co. O. L. Olson P. A. HydroRes—Pan-American Hydrocarbon Research Co. Parker—Parker, Steffens & Pearce Parsons—The Ralph M. Parsons Co. Petco—Petroleum Engineering Tool Co. Phillips—Phillips Petroleum Co. Pritchard—J. H. Pritchard Co. Procon—Process Construction, Inc. Quaker—Quaker Valley Constructors Ref. Eng.—Refinery Engineering Company S & B—Singmaster & Breyer Separator-Nobel Co. Socony-Vac.—Socony-Vacuum Oil Co. Southwestern—Southwestern Constr. Co. S. O. D.—Standard Oil Development Co. Sohio—Standard Oil Co. of Ohio Stearns-Roger—Stearns-Roger Manufacturing Co. Stone & Webster—Stone & Webster Construction Co. Sunland—Sunland Refining Company Sweco—Southwestern Engineering Co. Tears—Tears Engineers Tellepsen—Tellepsen Construction Company Texaco Dev.—Texaco Development Corp. Texaco—The Texas Co. Texas Natural—Texas Natural Gasoline Corp. U.O.P.—Universal Oil Products Company J. G. White—J. G. White Eng. Corp.



There's no maintenance problem where you use "CENTURY" corrugated asbestos-cement sheets



Diesel Repair Shop, Signal and Control Tower at the Settegast Freight Yard of the Missouri Pacific Lines at Houston, Texas. Buildings sided with long-lasting "Century" Corrugated Asbestos-Cement Sheets. Engineers and Builders: The Austin Company

As you know, among railroading's headaches are its many maintenance jobs. Here a big one was lopped from the list, right at the start—by the use of "Century" Corrugated Asbestos-Cement Sheets . . . because roofs and siding of "Century" Asbestos Corrugated reduce upkeep to a minimum.

Buildings so constructed provide permanent protection for men, equipment, materials and finished products. "Century" Asbestos Corrugated *can not burn, rot or rust;* rodents and termites can't hurt it; it resists many chemical fumes. And regardless of climate, driving winds and deluging rains, it never needs protective painting to preserve it!

This unique material can be applied quickly, easily and inexpensively. The sheets are very strong, yet can be cut and drilled with ordinary working tools, and fastened in place with a minimum of labor.

If you are planning to construct from the ground up, or need merely to "re-cover" an old building, give earnest consideration to the outstanding money-saving qualities of "Century" Corrugated Asbestos-Cement Sheets for both roofing and siding. We'll be glad to send you complete details on request.

Nature made Asbestos . . .
Keasbey & Mattison has made it serve mankind since 1873

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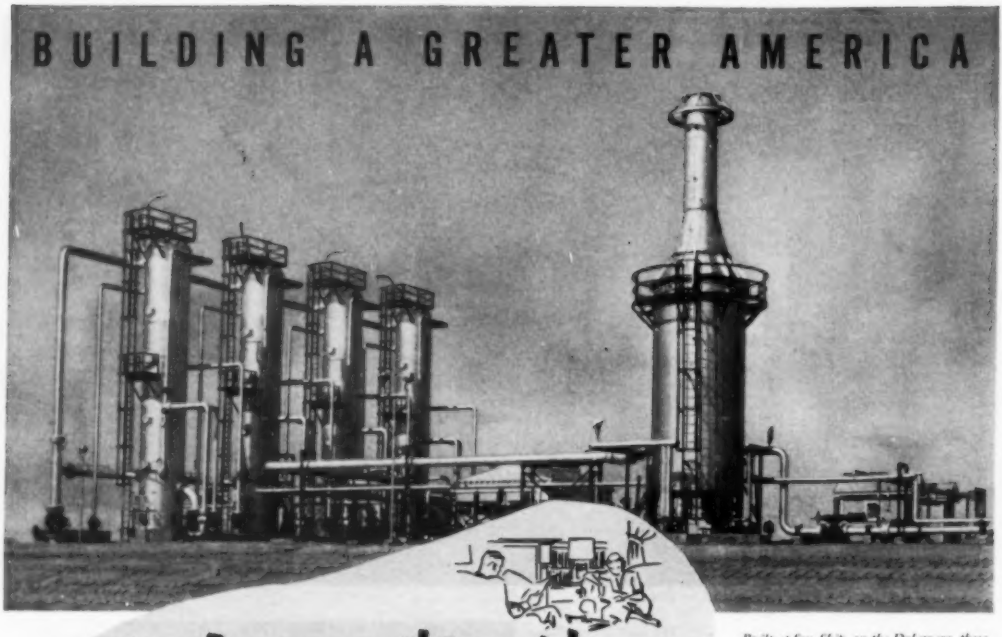
BUILDING A GREATER AMERICA



Built at Sun Ship, on the Delaware, these dehydrating towers now serve Western homes and industries.

Across the wide Missouri

Pioneers in prairie schooners blazed a courageous trail "across the wide Missouri . . ." and across the entire continent . . . in their search for new opportunity.

The industrial services of modern America have followed in that trail. Thriving farms, towns and cities mark sites where pioneers found only hardship . . . because American industry is truly "All-American."

Today, *all* America shares the benefits of *all* of America's progress . . . because great companies develop and distribute the advantages latent in our natural resources . . . and because great industries like Sun Ship can build and deliver, anywhere in the world, the gigantic equipment needed to convert petroleum and various chemicals into light, heat, power and the other productive forces which serve mankind's comfort and progress.

Sun

SHIPBUILDING & DRY DOCK COMPANY

SINCE 1916

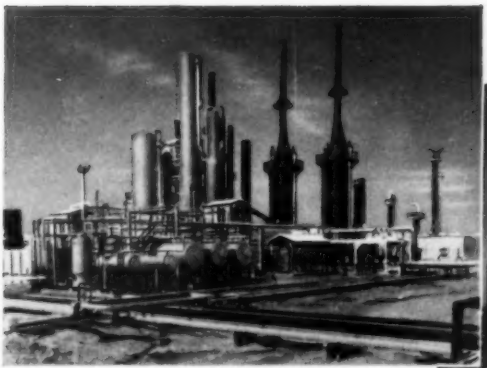
ON THE DELAWARE • CHESTER, PA.

25 BROADWAY • NEW YORK CITY

20,000 barrels per day of Alberta Crude oil are processed in the units of Canadian Oil Refineries' Sarnia, Ontario, plant on the St. Clair River

HIGH OCTANE FOR Canada

The design and construction of the new Sarnia refinery of Canadian Oil Refineries Limited were managed by Stone & Webster Canada Limited utilizing the facilities of Stone & Webster Engineering Corporation. It is the first fully integrated refinery in Canada entirely employing the latest processes for producing maximum yields of high octane gasoline. The project includes special equipment to prevent pollution of the river.



Crude Distillation Unit

Catalytic Cracking Unit

STONE & WEBSTER ENGINEERING CORPORATION

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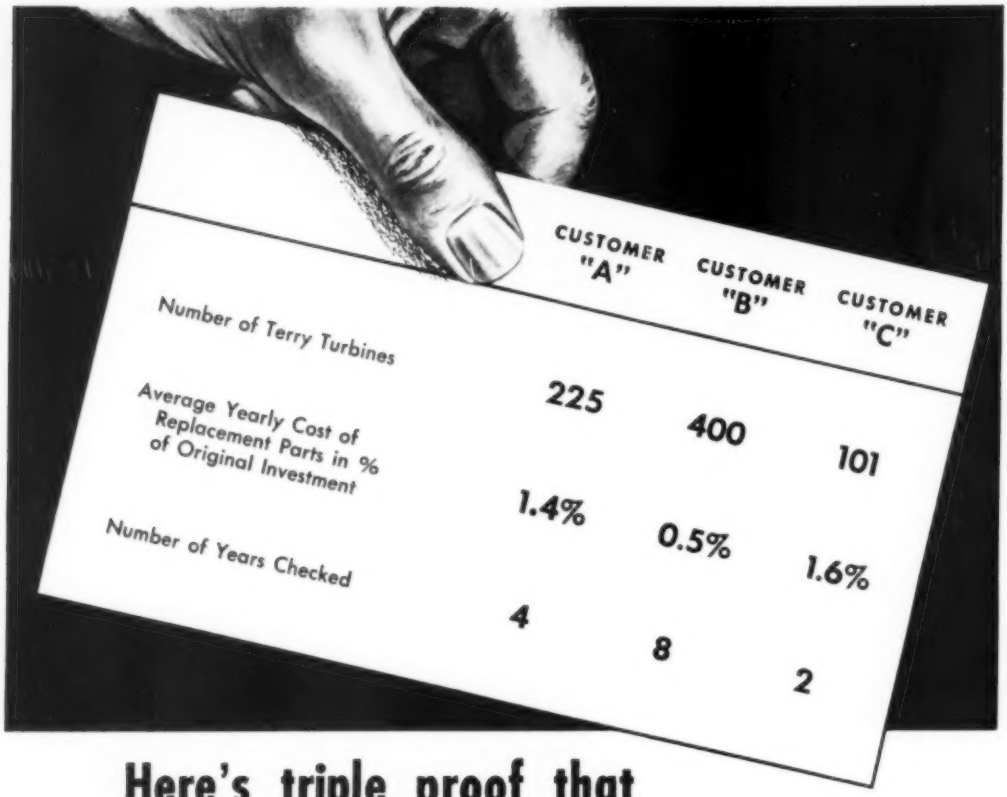

Here's triple proof that
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Analyze Cooling Tower Performance by This Method

A new concept makes it possible to predict performance ratings of proposed towers while still in design stage

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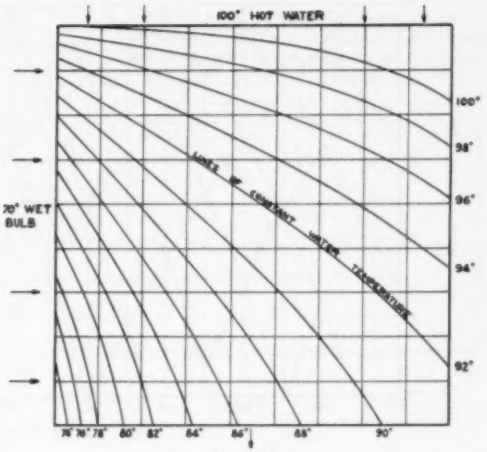

Figure 1

THE UNIT-VOLUME coefficient, presented here, is an adaptation of the transfer-unit concept which offers a means of determining the fraction of a transfer-unit represented by one cubic foot (or unit-volume) of tower. The result is that integration is accomplished by increments of equal volumes and this makes it possible to analyze both crossflow and counterflow towers.

The problem of analyzing cooling tower performance is divided into three separate steps:

- Development of the theoretical basis which is likened to a yardstick that may be used to evaluate performance conditions.
- Correlation between the theoretical calculation and actual test data. This serves to calibrate the yardstick and make it applicable to a specific piece of equipment.
- How cooling tower characteristics may be compared and evaluated.

History of Theoretical Analysis

The first to consider the problem seems to have been Robinson[1] in 1922 and Walker, Lewis and McAdams[2] in 1923. In both instances the authors developed the basic equations for mass and heat transfer and considered each process separately. It is interesting to note that Robinson referred to, but did not use, the Lewis[3] relationship:

$$\frac{a}{k} = c \qquad (1)$$

in which a = coefficient of heat transfer, Btu per (hr.) (sq. ft.) (°F.)

k = coefficient of mass transfer, (lb. water evap.)/(hr.) (sq. ft.) (lb., vapor/lb., dry air)

c = specific heat of air, Btu per (lb.) (°F.)

It remained for Merkel[4] to utilize the Lewis relationship to combine the coefficient of sensible heat and mass transfer into a single over-all heat transfer coefficient based on enthalpy potential difference as the driving force. Merkel then reduced the functions to a single cooling diagram. The assumptions necessary to accomplish this introduced serious errors.

Later editions of the text by Walker, Lewis and McAdams adopted the approach suggested by Merkel and applied the transfer-unit to the analysis of cooling tower performance. Lichtenstein[5] handled the basic equations in a slightly different manner, and also presented a method of plotting both the basic calculations and tower characteristics in a manner designed to facilitate cooling tower selection.

Simplifying the Problem

All of these analyses adopt certain assumptions to simplify the problem. They neglect the reduction in the mass flow rate of the water due to evaporation. The resulting error is negligible in most cooling applications but may introduce a noticeable error when long cooling ranges are involved. The calculations use the enthalpy of a saturated mixture of air and water vapor, assuming it to be a measure of the enthalpy of any mixture having an equal wet-bulb temperature. The error introduced by this assumption is due to the fact that the enthalpy of the saturated mixture will be slightly greater by an amount equal to the heat of liquid of the quantity of water necessary to saturate the mixture. Most methods assume that each particle of water is surrounded by a film of air that is saturated with moisture and at the temperature of the water. A more rigorous analysis developed by Mickley[6] considers temperature and humidity gradients, heat and mass transfer coefficients from water to film, and from film to air. The processes involved in a cooling tower are necessarily complex, and it is difficult to obtain the test data necessary to evaluate them. The analysis offered by Mickley offers a possible means of accomplishing this.

Any theoretical analysis of the cooling process considers only the mass and energy balances within the system and is independent of any particular piece of equipment. The resulting calculations are a measure of the *degree of difficulty* represented by the performance conditions. The equipment itself enters the problem only when experimental data yield the size or extent of the equipment necessary to accomplish the desired performance. The unit-volume coefficient offers a means of correlating the theoretical analysis with the actual equipment when the experimental data is available.

Unit-Volume Coefficient

The work of Merkel established the validity of the commonly observed fact that the performance of a cooling tower is a function of wet-bulb temperature. This indicates that the difference in enthalpy existing between the film of air surrounding the water and the main mass of air provides the driving force in the cooling process. A consideration of these facts led to the hypothesis that the cooling of the

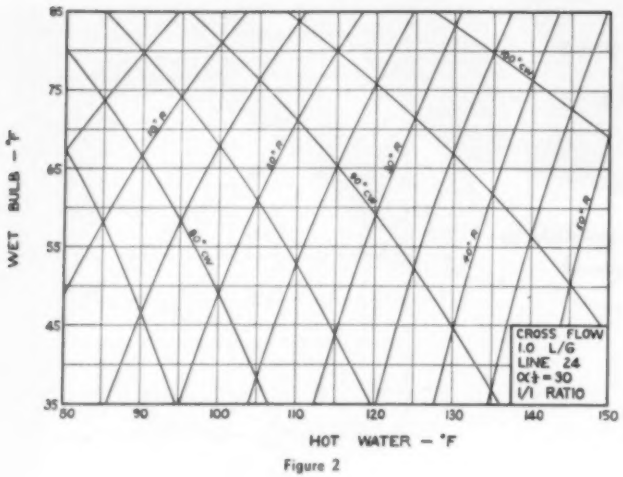

Figure 2

water is proportional to the enthalpy potential difference and may be expressed as an overall coefficient per unit of volume. This hypothesis is compatible with the transfer-unit concept. A transfer-unit in a cooling tower is large, and the essence of the unit-volume coefficient is the determination of the fraction of a transfer-unit represented by one cu. ft. of tower. By definition, this determines the unit-volume coefficient as Btu transferred per cubic foot of tower per square foot of plan area per Btu difference in enthalpy potential. The theoretical basis for this hypothesis is developed in the appendix. The method is applied to a specific problem by selecting some fraction of a transfer-unit, and determining the number of fractions represented in the cooling process by mechanical integration. The number of fractional transfer-units is then used to determine the unit-volume coefficient as illustrated in the following example.

Example: *Counterflow Calculations*

Assume a counterflow cooling tower having a height Z equal 14 feet operating with water entering the top of the tower at 100 F. and being cooled to 85 F. with an entering wet-bulb temperature of 70 F. and a liquid/gas ratio of 1.2 pounds water per pound air.

Solution: A fractional transfer-unit, as defined in the appendix, is

$$\alpha \frac{L}{G} = \frac{h''-h}{\Delta t} \qquad (A\text{-}6)$$

If we let $\alpha \frac{L}{G} = 10$, this becomes

$$\frac{h''-h}{\Delta t} = 10$$

and the water passing through each incremental volume having a height ΔZ will be cooled one degree for each 10 Btu difference in enthalpy potential.

Neglecting changes of state within the incremental volume, the water leaves the bottom of the tower at 85 F. and is assumed to be surrounded by a film of saturated air at the same temperature having an enthalpy (h″) of 49.43 Btu. Air entering the bottom of the tower at a wet-bulb temperature of 70 F. has an enthalpy (h) of 39.09 Btu, so the driving force (h″—h) is 15.34 Btu in the lower incremental volume. The temperature change of the water will be $\frac{15.34}{10} = 1.534$ F. Since 1.2 pounds of water passes through the incremental volume for every pound of air, the enthalpy change in the air is $1.2 \times 1.534 = 1.84$ Btu per pound dry air, and the air leaves it at $34.09 + 1.84 = 35.93$ Btu per pound of dry air. The water temperature in the next higher incremental volume is $85° + 1.53° = 86.53$ F., and the air film surrounding the water has an enthalpy of 51.33 Btu per pound dry air. The new driving force is 51.33 — 35.93 = 15.40 Btu per pound dry air, which determines the temperature change within the second incremental volume. The remainder of the mechanical integration is shown in Table 1.

The number of fractional transfer-units, or lines of integration, have been abbreviated to "lines" by usage and will be referred to as such.

The unit-volume coefficient (f) from Equation A-15 of the appendix is

$$f = \frac{1}{\alpha \Delta Z} \qquad (A\text{-}15)$$

Since the height of the tower is 14 feet, $\Delta Z = \frac{14}{9.12} = 1.535$ feet represent a volume of 1.535 cubic feet per square foot of plan area.

Also $\alpha \frac{L}{G} = 10$ so $\alpha = 10 \frac{G}{L} = 8.33$

therefore $f = \frac{1}{8.33 \times 1.535} = .0782$

$$\frac{\text{(Btu transferred)/(cu ft)/(sq ft)}}{\text{Btu Pot. Difference}}$$

The selection of a larger value for $\alpha \frac{L}{G}$ reduces the size of incremental volume and increases the accuracy of the mechanical integration. The change in size of the increment of volume is approximately an inverse ratio so the value of the coefficient will be approximately the same.

Crossflow Calculations

The same method of anaylsis may be applied to crossflow cooling although the calculations are more tedious. Only a single integration is needed in counterflow cooling because conditions are constant across any horizontal section. A double integration is necessary in crossflow cooling because of the temperature distribution as shown in Figure 1. The mechanical integration is accomplished by dividing the cross-section into a number of columns, each of which is sub-divided into a series of incremental volumes. The water enters the top of each column at the hot water temperature and is cooled progressively as it descends. The air enters each incremental volume of the outside column at the ambient wet-bulb temperature, picking up an amount of heat during its horizontal travel equal to the amount of heat removed from the water during its vertical fall through the incremental volume. Calculation of the outer column is necessary to determine the enthalpy of the air entering the next column, with calculations starting at top instead of at the bottom as is done in analyzing counterflow cooling. The mechanical integration of a crossflow tower must take into account the ratio of the lengths of air travel to water travel. The calculation of the coefficient uses the same Equation (A-15) that is used for counterflow cooling.

Basic Curves

The mechanical integration of the coefficient for a set of performance conditions is not too time consuming, but it is not possible to start with the coefficient and solve for the predicted performance conditions except by trial and error. This difficulty has been overcome by calculating the basic data for a sufficient number of performance conditions and plotting the data as a series of curves. The basic calculations consider five variables: hot-water temperature, cold-water temperature, wet-bulb temperature, liquid/gas ratio, and the number of fractional transfer-units as represented

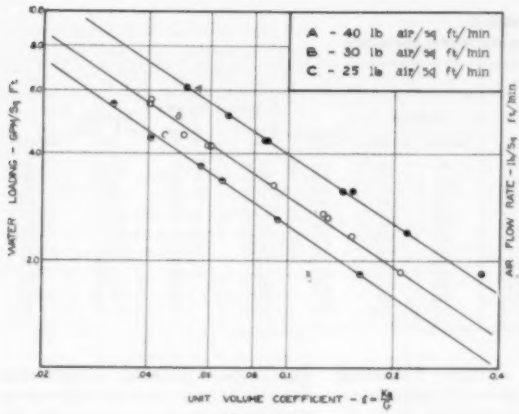
A - 40 lb air/sq ft/min
B - 30 lb air/sq ft/min
C - 25 lb air/sq ft/min
WATER LOADING - GPM/Sq Ft
AIR FLOW RATE - lb/Sq ft/min
UNIT VOLUME COEFFICIENT - $\frac{Ka}{G}$

Figure 3

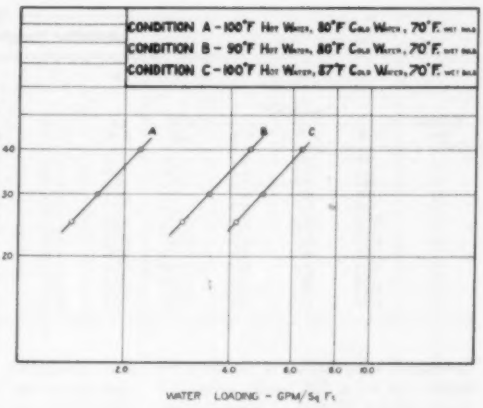
CONDITION A - 100°F Hot Water, 80°F Cold Water, 70°F. wet bulb
CONDITION B - 90°F Hot Water, 80°F Cold Water, 70°F. wet bulb
CONDITION C - 100°F Hot Water, 87°F Cold Water, 70°F. wet bulb
A
B
C
WATER LOADING - GPM/Sq Ft

Figure 4

by the number of lines of integration. Several investigators have attempted to construct a single curve or chart that will represent the performance of a cooling tower. Numerous attempts by the authors have failed to produce a single chart having the desired accuracy because of the number and nature of the variables involved, so a series of basic curves were developed. One of these curves is shown in Figure 2.

Various methods may be adopted for plotting the basic calculations, and the method shown in Figure 2 appeared to be the most useful and logical. Each curve represents the performance characteristics at a constant L/G ratio and line of integration. The coefficient may be calculated when the height of the tower under consideration becomes known. As will be shown later, the coefficient is a function of water loading and air velocity, so each basic curve represents cooling tower performance at constant water and air rates. The selection of wet-bulb and hot-water temperatures as coordinates of the curves and cold-water temperature as parameters was a result of earlier work developing performance curves empirically from test data. Plotting a set of test conditions locates one point on some curve of constant cold-water temperature. This curve must terminate at a point where the hot-water, cold-water, and wet-bulb temperatures are equal. Thus any set of test conditions will represent two points on the cold-water temperature curve. Adding range and approach curves makes it possible to obtain two cross plots on each graph.

The air velocity through a cooling tower is held within rather narrow limits for economic reasons, but is varied to adjust the increments of tower size to meet desired performance conditions. The water loading varies over a much wider range since this is the means of adjusting the tower characteristics to the desired set of performance conditions. A long cooling range and close approach of the cold-water temperature to the wet-bulb temperature represents a high degree of difficulty that is usually accomplished by a light water loading and a low L/G ratio. A short range and long approach represents a low degree of difficulty that can be accomplished by high water loadings and a high L/G ratio. These facts must be taken into account when preparing the Basic Curves so that low L/G ratios will be covered by a series of high lines of integration and the high L/G ratios by lower "lines."

TABLE 1

Lines of Integration ΔZ	Water Temperature	h' Enth. at Water Temp.	h Enth. of Air	$h'-h$	$\frac{\Delta t}{h'-h}$	$\frac{L}{G} \times \Delta t$
0	85.00	49.43	34.09	15.34	1.53	1.84
1	86.53	51.33	35.93	15.40	1.54	1.85
2	88.07	53.32	37.78	15.54	1.55	1.86
3	89.62	55.41	39.64	15.77	1.58	1.89
4	91.20	57.62	41.53	16.09	1.61	1.93
5	92.81	59.97	43.46	16.51	1.65	1.98
6	94.46	62.48	45.44	17.04	1.70	2.04
7	96.16	65.18	47.48	17.70	1.77	2.12
8	97.93	68.11	49.60	18.51	1.85	2.22
9	99.78	71.34	51.82	19.52	1.95	2.34
10	101.73	.....	.....	.....	.....	.....
9.12	100.00	(interpolating)				

Factors Influencing Performance

The performance of a cooling tower is a function of each of the five variables entering into the Basic Calculations, but it is desirable to rearrange these when considering the factors that determine the characteristics of an actual installation. Considering the definition of cooling tower performance as the cold-water temperature attained under a specified set of operating conditions, the variables affecting the performance are

1) Wet-bulb temperature of the entering air.
2) Water loading, gpm per square foot.
3) Cooling range, which defines the heat load if the water rate is specified.
4) Mass air rate.
5) Design characteristic. This includes such inherent qualities as type, size, shape, filling, etc. It also includes the over-all unit-volume coefficient.

The basic curves serve as a yardstick that may be used to measure and evaluate the five factors determining performance. Some of these factors may be easily controlled and held constant while determining the effect of variations of the others. Field tests are none too satisfactory for this purpose because of the difficulty of holding some variables constant while controlling variations in other factors. It is also difficult to attain the desired accuracy in a field test of a commercial installation. The authors' company established a test plant in 1935 where conditions approaching laboratory precision might be obtained, and the tower characteristics as described in this paper have, to a large extent, been determined there. Test models have included crossflow towers of the

TABLE 2
Tabulation Showing Hot Water Correction

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Test Run No.	Temperature			H. W. Adj.	Adj. H. W.	GPM Sq. Ft.	L/G	Coefficient		Average Coeff.	Predicted C. W. Without Adj.	Deviation From Actual C. W.	Predicted C. W. with Adj.	Deviation
	H W.	C. W.	W. B.					Before	Adjusted					
1	82.6	73.3	62.2	— 0.8	81.8	3.12	1.18	1.28	.955	.860	73.79	+ .49	73.46	+ .16
2	83.2	75.2	66.5	— 0.6	82.6	3.08	1.16	1.29	.920	.875	75.50	+ .30	75.25	+ .05
3	89.1	78.6	67.2	— 0.6	88.5	3.16	1.19	.962	.810	.835	78.79	+ .19	78.54	— .06
4	110.8	88.1	69.2	+ 1.0	111.8	3.14	1.18	.785	.860	.845	87.76	— .34	88.16	+ .06
5	97.8	81.0	63.0	— 0.4	97.4	3.14	1.18	.865	.820	.845	81.08	+ .08	80.93	— .07
6	107.4	86.4	67.8	+ 0.6	108.0	3.16	1.19	.815	.860	.835	86.27	— .13	86.51	+ .11
7	140.5	97.2	70.0	+14.2	154.7	3.18	1.19	.563	.815	.825	94.99	—2.79	97.12	— .06
8	135.7	94.4	65.3	+10.5	146.2	3.10	1.17	.602	.850	.863	92.52	—1.88	94.34	— .06
9	130.2	94.0	68.0	+ 7.4	137.6	3.20	1.21	.620	.845	.818	92.62	—1.38	94.18	+ .18
10	121.5	91.8	69.2	+ 3.5	125.0	3.19	1.20	.675	.825	.820	90.91	— .89	91.83	+ .03
11	93.6	82.0	71.0	— 0.5	93.1	3.13	1.18	.945	.827	.850	82.15	+ .15	81.95	— .05
12	100.3	85.5	72.5	+ 0.1	100.4	3.14	1.18	.825	.850	.845	85.43	— .07	85.52	+ .02
13	120.5	92.4	70.9	+ 3.2	123.7	3.13	1.18	.615	.750	.850	91.01	—1.39	91.83	— .57

"package" type having a two-foot fill height up to a full scale industrial tower having 18 feet of water travel. Counterflow towers have varied in size from 6 to 18 feet square, with the fill heights varying from a few feet up to 20 feet.

The basic calculations were started in 1944 and completed in time for use during the 1946 season. The initial tests were quite complete until the trends and methods of correlation were established. The water loadings were varied from less than one to over 14 gpm per square foot. Heat loads at the various water rates were varied from a few degrees of cooling range up to hot-water temperatures above 150°. Tests have been conducted during freezing weather, as well as at times when the entering air wet-bulb temperature was artificially raised to 90 F. These tests proved the validity of the method and established its limitations. Test procedures and methods of correlation were developed during the analysis of these tests that greatly simplified the later investigations. Such test work made it possible to evaluate the factors that determine the tower characteristics.

Correlation of Test Data

The correlation of the test data consists of selecting the Basic Curve that coincides with the test conditions. This usually requires a double interpolation to select the proper "line" at the prevailing L/G ratio. The coefficient is then calculated by Equation (A-15.) The method of correlation is illustrated by the two examples that follow.

Example 1: *Showing Deviations From The Basic Curves*

The first correlations resulted in considerable scattering of the test points although a line drawn through the average of the plotted points could be used to predict performance with a fair degree of accuracy. An examination of the test data revealed that the deviations closely followed changes in the hot-water temperature. This led to the development of an empirical "hot-water correction factor" that greatly reduced the magnitude of the deviations and increased the accuracy of the method. Table 2 shows data on a series of test runs conducted at constant water and air rates for the purpose of determining the hot-water adjustment for the tower in question. The correlation at 100 F. hot-water temperature was selected as the base, and the other hot-water temperatures were adjusted to correlate on that base.

Columns 2, 3 and 4 of Table 2 show the actual hot-water, cold-water and wet-bulb temperature readings.

The hot-water adjustment is shown in Column 5, and the adjusted hot-water temperature in Column 6.

The coefficient, as determined from the actual test data, is shown in Column 9. The coefficient based on the adjusted hot-water temperature is shown in Column 10. This value should be constant at a constant water rate as will be shown later.

An average coefficient, as described in Example 2, based on the adjusted hot-water temperatures was used to determine the coefficient corresponding to water loading as shown in Column 11. These values should be the same as Column 10, except for experimental errors.

The coefficient in Column 11 was used to calculate Column 12 showing the predicted cold-water temperature corresponding to the actual test data. Column 13 shows how these deviate from the actual readings in Column 2. The deviations vary from 0.49 F. high to 2.79 F. low.

The calculated cold-water temperatures based on the adjusted hot-water temperature is shown in Column 14, and the deviations are shown in Column 15. Seven of the test runs average 0.09 F. high with a maximum deviation of 0.18 F. Six average 0.15 F. low with a maximum of 0.57 F. The over-all accuracy is shown by the fact that the 13 runs average 0.02 F. low.

The deviation of the actual performance from the basic curves as compensated by the "hot-water correction factor," may be due to inherent fallacies in the hypothesis, or to errors resulting from some of the approximations or assumptions entering the calculations. The latter is plausible because the theoretical calculations are based on the assumption that each particle of water is surrounded by a film of air that is at the temperature of the water and saturated with moisture. This represents an ideal condition that cannot exist. Temperature gradients will exist within each particle of water, as well as between the water and film, and the film will not be completely saturated. The theoretical calculations use film temperature to determine the driving force, so the water temperatures shown on the basic curves actually represent the temperature of the film rather than of the water. The hot-water adjustment may logically be a measure of the temperature differential between the film and water which increases in magnitude as the water temperature increases. This might be explored to advantage by following the approach proposed by Mickley.[6]

Example 2: *Showing Effect of Varying Water And Air Rates*

Heat transfer is a function of velocity so it is logical to assume that the coefficient will increase as the mass air velocity increases. Tests show this to be the case, and it has been found that the variations may be closely approximated by the equation

$$\frac{L_1}{L_2} = \left(\frac{G_1}{G_2}\right)^n \qquad (2)$$

in which G_1 and G_2 represent mass air rates, and L_1 and L_2 represent water rates that result in the same performance with respect to hot-water, cold-water, and wet-bulb temperatures.

The cooling per pound of water decreases as the water rate increases, so the "line" and coefficient decrease as the water loading increases. Table 3 contains the test data on three series of runs that show the effect of variations of both air and water rates. Each

series represents a different mass air rate, while the runs within a series cover varying water loadings at a constant air rate. The hot-water temperatures are adjusted for each run as in the previous example, and the water loadings are corrected by the use of Equation 2 to compensate for the slight variations in air rate. It is necessary to assume the value of the constant "n" when making this correction and determine its true value later. Figure 3 shows the correlation curves for the three air rates which plot as straight lines that are approximately parallel when using logarithmic coordinates. The sensitivity of this tower characteristic curve is illustrated by the fact that a change in the value of the coefficient representing a horizontal distance of one inch when the 7½-inch cycle coordinates are used, will represent a change in cold-water temperature of less than one degree.

Figure 4 shows the plot of water loading vs. air rate for three performance conditions, using data obtained from Figure 3. The slope of the three lines represents the value of "n" in Equation (2.) for the tower in question. The values are:

Condition	A	.957
	B	.935
	C	.922

The slope varies slightly for the various performance conditions, but an average value may be used without introducing serious error.

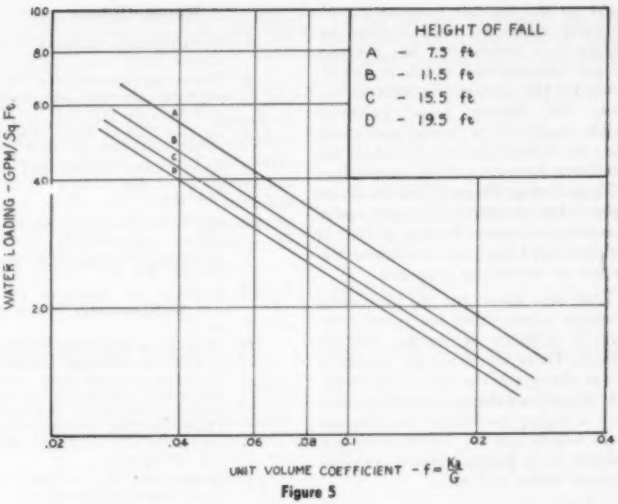

Figure 5

Cooling Tower Characteristics

The heat transfer surface in a cooling tower is the exposed area of the water passing through the equipment. The water passing through a tower may be divided up into 1) the layer of water covering the wetted area of the structure and filling, 2) the water dropping from the structure or filling, and 3) the drops formed by the spray nozzles or splash plates in the distribution system. Laboratory procedures have been set up by numerous investigators to study the cooling characteristics of the various types of surface, but a commercial installation contains an uncontrolled mixture of all of them. The heat transfer surface of a spray tower will consist primarily of the surface of the drops that are produced by the spray nozzles. Adding filling to such a tower increases the wetted surface, and the filled section becomes part of a compound tower operating in series with the spray section. Counterflow towers operate crossflow at the air inlet and counterflow after the air makes a right angle turn. This combination of flow usually does not occur in crossflow towers. Pressure distribution systems are seldom used in crossflow towers so the complication of a spray section operating in series with a filled section does not arise. All of these variations influence the characteristics of a cooling tower so each type of tower must be considered separately.

TABLE 3

Run No.	Actual H. W.	Adj. H. W.	C. W.	W. B.	Lb. Air / Ft.²-Min.	GPM / Ft.²	GPM/Ft.² Corrected	Coeff.
SERIES 1-25 POUND AIR/FOOT²/MINUTE								
1	105.4	106.4	88.6	52.6	24.7	5.46	5.52	.0318
2	108.6	110.0	86.6	55.5	25.2	3.70	3.68	.0565
3	104.8	105.4	86.3	54.0	25.0	4.39	4.39	.0406
4	110.5	112.3	77.9	50.2	26.2	1.90	1.82	.1610
5	111.2	113.0	78.6	52.1	26.2	1.90	1.82	.1610
6	103.7	104.3	82.9	54.0	25.4	3.38	3.33	.0650
7	108.0	109.2	82.3	54.4	25.7	2.66	2.59	.0933
SERIES 2-30 POUND AIR/FOOT²/MINUTE								
1	112.8	114.8	86.8	63.0	30.3	3.24	3.21	.0909
2	110.0	111.7	80.5	63.2	31.2	1.92	1.85	.2090
3	105.3	106.3	75.7	46.0	32.4	2.48	2.31	.1520
4	100.5	100.6	83.2	48.5	30.3	5.50	5.45	.0403
5	101.3	101.5	82.5	51.6	30.6	4.56	4.47	.0504
6	101.0	101.1	80.7	53.0	31.0	3.74	3.63	.0699
7	103.4	104.0	85.0	48.2	30.2	5.65	5.62	.0407
8	108.6	110.0	85.0	50.6	30.6	4.26	4.18	.0604
9	107.8	109.0	84.9	51.4	30.6	4.26	4.18	.0589
10	106.8	107.8	79.2	51.2	31.2	2.78	2.68	.1260
11	106.8	107.8	78.8	50.9	31.2	2.72	2.62	.1295
SERIES 3-40 POUND AIR/FOOT²/MINUTE								
1	100.5	100.6	76.0	53.0	40.3	3.13	3.11	.1520
2	101.0	101.1	76.7	53.8	40.3	3.13	3.11	.1425
3	106.0	107.0	72.0	52.6	41.5	1.89	1.83	.3550
4	97.0	96.6	72.2	52.4	41.0	2.44	2.39	.2170
5	97.8	97.5	81.0	52.4	38.8	5.99	6.17	.0512
6	101.5	101.7	80.4	54.6	39.7	4.32	4.35	.0856
7	102.0	102.3	80.7	55.2	39.7	4.32	4.36	.0870
8	98.0	97.8	80.1	54.6	39.2	5.03	5.12	.0673

Spray-Filled Counterflow Towers

The spray-filled counterflow tower is the simplest type and will be considered first. The water is broken up into drops as it passes through the spray nozzles and these drops fall through the ascending air stream. Cooling occurs at the surface of each drop, creating a temperature gradient within each drop that tends to be equalized by conduction and diffusion within the drop. A drop falling from an infinite height will be cooled to the wet-bulb temperature of the entering air at which time no temperature gradient will exist within the drop. The height of fall in a commercial tower is so small that the temperature gradient increases in magnitude as the drop falls through the tower. The theoretical calculations are

based on the *average* temperature of the water within any volume while the cooling is a function of the average *surface* temperature which is lower. Lowering the surface temperature reduces the driving force potential which results in a lower coefficient when the calculations are based on the average temperature of the water. This is illustrated in Figure 5 which shows typical characteristics of a spray tower operating at various heights of fall. It will be noted that the coefficient decreases as the height increases.

Tests also show that the coefficient increases when either the spray pressure or number of nozzles are increased. These variations are probably due to changes in the size of the drops. It is also found that a down-spray will have a higher coefficient than an up-spray which may be due to more turbulence or a higher relative velocity between water and air.

Wood-Filled Counterflow Towers

Adding filling to a counterflow tower adds wetted surface, and increases the time of contact by interrupting the fall of the drops. As the drops of water collect and reform on the filling, new surface is exposed and extreme temperature gradients within the drops are prevented. Nevertheless, the coefficient continues to decrease as the height increases, but the variation is less than that found in spray towers. The same trends found in spray towers with respect to up-spray vs. down-spray, nozzle pressure, and number of nozzles also occur in counterflow towers containing filling.

The number of variables affecting the coefficient of counterflow towers makes it difficult to establish a correlation curve for varying water rates. A change in water rate may be accompanied by a change in spray nozzles to maintain a constant pressure, but this offers no assurance of a constant water distribution due to differences in the characteristics of the nozzles.

Crossflow Towers

Changes in water rate do not affect the water distribution of a crossflow tower. No spray is present to operate in series with the filled section so the coefficient reflects only the performance of the filling. The result is that less variation occurs when plotting crossflow performance data. The coefficient of a given design varies only with changes in water loading and mass air rate and is not affected by variations of tower height. This is as we should expect if the hypothesis of the unit-volume coefficient is correct.

Effect of Varying Air Rate

The cooling capacity of both crossflow and counterflow towers varies closely as a power ratio of the mass air velocity in accordance with Equation (2.) The constant "n" is usually less than unity and seems to vary with the design of the filling, as well as with the type of tower. The values close to or greater than unity that occur occasionally may be due to changes in the characteristics of the fill pattern resulting from the varying air velocities. Such an explanation is more logically reconciled to crossflow towers where the air movement may cause the falling water to miss one layer of fill and strike a lower level. However, the higher power ratios are found in both crossflow and counterflow towers. The high ratios in counterflow towers may be due to an action called reflux in fractionating columns, caused by fine drops being carried up in the tower and falling again.

Nomenclature

- A Cross-sectional area of tower, square feet.
- a Water surface exposed to energy transfer per unit volume of tower, sq. ft./cu. ft.
- c Specific heat of water, assumed to be unity, Btu per (lb.) (°F.)
- f Unit-volume coefficient, defined as $\frac{Ka}{G}$
- G Air rate, lb./(hr.) (sq. ft. of tower cross-section).
- h Enthalpy of main mass of air, Btu/lb. dry air.
- h″ Enthalpy of saturated air at water temperature, Btu/lb. dry air.
- K Over-all average unit energy-transfer conductance per sq. ft. of water surface area within the tower, and based upon an enthalpy-difference potential, (Btu)/(hr.)(sq. ft. water surface)/(Btu)/lb. enthalpy potential difference.
- L Water rate, lb. per (hr.) (sq. ft. of tower cross-section).
- TU A subscript used with Δt and Δh denoting a specific increment that yields a **transfer-unit.**
- t Temperature of the water, °F.
- V Active volume of tower, cu. ft.
- Z Height of active volume of tower, feet.
- α A constant, defined as $\left(\frac{h''-h}{\Delta t}\right)\left(\frac{G}{L}\right)$, and having units $\frac{\text{Btu enthalpy potential}}{\text{Btu transferred}}$

Fill Pattern

Tests of both crossflow and counterflow filling show that the pattern of the fill has some effect on the coefficient. Variations of the arrangement of the same amount of fill will affect the coefficient to some extent. The greatest variation in performance is a result of changing the amount of filling. Increases follow the law of diminishing returns when a constant air velocity is considered, but additional filling increases flow resistance so may result in no net gain if comparison is made at a constant input horsepower to the fan. The amount of filling in an industrial cooling tower is usually below this point.

Tower Height

The effect of increasing tower height is similar to increasing the amount of fill. The result is that it is usually more economical to increase the amount of fill in a lower tower than in a high one. The effect of variations in height on tower performance must consider changes in mass air flow. An increase in performance resulting from an increase in height means that a greater water quantity will be handled at the same performance conditions. If the mass air rate remains constant, an increase in water rate results in a higher wet-bulb temperature of the outgoing air. The temperature of the air leaving the tower can approach, but not exceed, the temperature of the water entering the tower. This means that the increase in capacity due to an increase in height definitely follows the law of diminishing returns if a constant mass air rate is maintained.

An increase in mass air velocity results in an increase in static pressure loss. This, combined with an increase in pressure drop resulting from an increase in the length of air travel, definitely limits the economical increase of total air flow in a counterflow cooling tower. A constant mass air velocity may be maintained in a crossflow tower with no change in static pressure drop. In that case it is possible to increase the tower capacity per pound of air with an increase in tower height.

"Wall Effect"

Various investigators have commented on the "wall-effect" of experimental towers, claiming that the relatively large amount of wall area in small towers adversely affects performance. It is conceivable to have a small tower using a single spray nozzle for distribution that will operate with most of the water flowing down the walls. The results reported in this paper include tests where the water flowing down the walls was collected, measured, and its temperature obtained. Using reasonable care to prevent such extremes, it has not been found necessary to make any correction for wall-effect. The tower characteristics developed in experimental units have been checked against field

tests with remarkable accuracy.

Limits of Water Loading

Other investigators have placed an upper and lower limit on water loading, some even stating that a loading between 2 and 5 gpm per square foot gives optimum performance. The explanation offered for this is that a light loading results in poor water distribution and unequal wetting of the filling while a high loading causes what is referred to as flooding, but this is a poor term to describe any condition that may occur in a cooling tower. Tests at water loadings both above and below the usual limits show no discontinuity in the correlation curve. Performance conditions requiring a light water loading may often be handled more economically by using a tower of smaller plan area but containing a more closely packed fill, or by a higher tower of less plan area. Such alternates are a matter of economic selection rather than optimum water loading. Other performance conditions such as the cooling of engine jacket water from 160 to 140 F. may be accomplished with extremely high water loading.

Relationship Between Water Loading and Draft Loss

Heavy water loading may become a problem when spray nozzles are used in the distribution system. The water leaving the orifice of the nozzles forms a cone that can become a serious obstruction to the air flow. A large part of the draft loss through a cooling tower is the result of the work done by the air in moving the water horizontally in a crossflow tower, or in retarding its fall in a counterflow tower. This draft loss is a direct function of the water loading, but it shows no discontinuity as the water rate increases.

Conclusions

The results of laboratory and field test data substantiate the validity of the unit-volume coefficient method of cooling tower analysis. Considering the magnitude of the experimental errors as well as the difficulties encountered in obtaining accurate test data, the accuracy of the method is higher than anticipated.

The use of the method has made it possible to

1) refine testing technique.
2) test experimental filling in small scale test models, and predict the performance in full scale towers.
3) predict performance ratings of proposed towers while still in the design stage.
4) study the effect of outside influences on cooling tower performance. These include recirculation, effect of wind velocity and direction, and the interference from surrounding structures.

Regardless of the validity of the theoretical basis for any method of cooling tower analysis, its application is purely a matter of empirical correlation. The unit-volume coefficient has proven to be quite easy to correlate with experimental data. Its sensitivity and accuracy makes it possible to study fundamental relationships.

APPENDIX

THEORETICAL BASIS OF UNIT-VOLUME COEFFICIENT

An energy transfer-unit in a cooling tower is given by the value of the enthalpy change $(\Delta h)_{TU}$ of the air stream which yields

$$\int_{h}^{h+(\Delta h)_{TU}} \frac{dh}{h''-h} = 1 \qquad (A\text{-}1)$$

The energy balance between the air and water streams is

$$Lcdt = Gdh \qquad (A\text{-}2)$$

or

$$dh = \frac{L}{G} cdt \qquad (A\text{-}3)$$

Therefore, the corresponding transfer-unit measured in terms of water temperature is whatever $(\Delta t)_{TU}$ will give the result that

$$\int_{t}^{t+(\Delta t)_{TU}} \left(\frac{L}{G}\right)\left(\frac{cdt}{h''-h}\right) = 1 \qquad (A\text{-}4)$$

Taking $\frac{L}{G}$ as constant, this becomes

$$\int_{t}^{t+(\Delta t)_{TU}} \frac{cdt}{h''-h} = \frac{G}{L} \qquad (A\text{-}5)$$

The transfer-unit as thus defined is quite large so it is advantageous to use terms in increments of $(\Delta t)_{TU}$. If the transfer-unit is divided into α increments, the equation for the fractional transfer-unit becomes

$$\int_{t}^{t+\Delta t} \frac{cdt}{h''-h} = \left(\frac{1}{\alpha}\right)\left(\frac{G}{L}\right) \cong \frac{c\Delta t}{h''-h} \qquad (A\text{-}6)$$

This defines α as $\alpha = \left(\frac{h''-h}{c\Delta t}\right)\left(\frac{G}{L}\right)$ (A-7)

When the value of α is such that the height of the fractional transfer-unit, as defined in Equation (A-6), is one foot; then the right hand side of the equation $\frac{c\Delta t}{h''-h}$ represents the unit-volume coefficient.

Since the rate of energy loss from the water equals the rate of energy transferred to the air, we can write

$$A\ L\ cdt = Ka(h''-h)dV \qquad (A\text{-}8)$$

or

$$\frac{h''-h}{cdt} = \frac{AL}{KadV} \qquad (A\text{-}9)$$

Integrating over the volume increment ΔV with the corresponding water temperature increment Δt, and taking $\frac{Ka}{LA}$ as an over-all average constant quantity, gives

$$\frac{Ka\Delta V}{AL} = \int_{t}^{t+\Delta t} \frac{cdt}{h''-h} \cong \frac{c\Delta t}{h''-h} \qquad (A\text{-}10)$$

From Equations (A-6) and (A-10), we get

$$\frac{Ka\Delta V}{AL} \cong \frac{c\Delta t}{h''-h} = \left(\frac{1}{\alpha}\right)\left(\frac{G}{L}\right) \qquad (A\text{-}11)$$

If Δt corresponds to some fraction of a transfer-unit which is limited in size by the variations of $(h''-h)$ over the interval Δt, then ΔV is a corresponding fraction of the tower volume

From Equation (A-11)

$$\left(\frac{L}{G}\right)\alpha = \frac{AL}{Ka\Delta V} = \frac{A}{\frac{Ka\Delta V}{L}} \qquad (A\text{-}12)$$

since $\Delta V = A\Delta Z$ (A-13)

We get by substituting Equation (A-13) in (A-12)

$$\left(\frac{L}{G}\right)\alpha = \frac{A}{\frac{KaA\Delta Z}{L}} \qquad (A\text{-}14)$$

or

$$\frac{Ka}{G} = \frac{1}{\alpha\Delta Z} = f \qquad (A\text{-}15)$$

The unit-volume coefficient (f) has the units

$$\frac{\text{(Btu transfer)/(cu. ft. of tower/sq. ft. plan area)}}{\text{Btu enthalpy potential}}$$

NOTE

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Wages and Salaries— How to Administer Them

A hit-or-miss program is not good enough. Here is a detailed description of a workable system

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OF ALL FUNCTIONS that are delegated by management, the administration of the wage and salary policy is perhaps among the most important. Any decisions made in its administration have a direct effect upon the worker and his attitude toward his job and his company. Since the primary motive that brings people to work is the economic need to earn a living, the worker's feeling about fairness of his compensation is crucial. At the same time there is a responsibility toward management in controlling wages and salaries in such a manner that, in addition to an employe's receiving a fair return for his services, the policy must be sound and consistent with the company's ability to pay.

Three Basic Rules

Here are three basic rules for any good wage and salary administration program:

- Management sets the over-all policy.
- First line supervisors must have the responsibility for, and authority to, administer the program.
- The program must be fair and equitable.

Many companies now have some type of wage and salary program in effect, whose basic aim is to accomplish the above objectives. The programs themselves are different inasmuch as they are designed to fit the peculiarities of each organization. However, the problems of administration remain basically common to all plans, and it is these problems that are discussed below.

Although many companies are now using job-evaluation techniques and some form of wage and salary control through random or rate-range methods, many have failed to sell their employes on the fact that its basic purpose is to insure fair treatment. Without this understanding, many programs do not receive the full backing they should from all levels of management. We know that the superiority of job evaluation over other methods of determining compensation is that it provides a consistent, rational method of comparing the value of one job to another and insuring internal and external consistency for the establishing of a fair value for the job.

Any wage program, to be effective, must be understood by those who administer it and by those to whom it will apply. Questions from employes are usually directed to their immediate supervisor; and unless the supervisor fully understands the program, he will be unable to give an intelligent answer to those he supervises. This will not only reduce its efficiency; but the supervisor will tend to reject the program orally, as a defensive measure, because of his inability to explain it. This is human nature. An individual is reticent to display ignorance on a policy that he is expected to administer, and will use the only defensive measures at his command—rejection and ridicule.

Another problem which arises is the controlling of wages and salaries. There are many factors at work within and without every company which tend to influence wage policies, of which we may or may not have control. From within we have company policy, which dictates our relative status to our industry or area. From without we have the unions' ever-present appetite for wage increases, which also tends to influence the unorganized wage and salaried groups. Another important factor which tends to influence our rates is economic conditions. It is now the height of fashion to hitch our wagon to the Bureau of Labor's Cost of Living Index. The cost of living wage adjustment moves in only one direction —upward—because of strong union opposition to a money-wage reduction. If consumer prices move upward, the rise of the cost of living tends to become a standard argument for a demand for a wage increase, with the resultant ulterior motive of the union to raise the real wage as well.

Line Organization Administration

In addition to the above factors, most companies have a wage and salary committee, whose responsibility is to administer the over-all policy. This committee, to be effective, must be a committee of executives who thoroughly understand the entire program and have commensurate authority to administer it. The most sound wage and salary program is one which a company's line organization, which generally shirks its personnel responsibilities, can and will administer.

Someone has defined a "committee" as a "group that keeps minutes and wastes hours, and who individually can do nothing, but collectively agree that there is nothing to be done." Obviously the wage and salary committee must have higher standards.

If operating executives aid in the formulation of policy and decisions, they will see that the program receives its fullest cooperation. If it is line administered, it is line accepted. If it is staff administered, it is subject to constant attack because those affected feel that they are being forced to participate in something which affects them, but of which they are not a part. This point is well worth examining to determine whether you have an effective operating program or one just receiving "lip service."

Wage and Salary Surveys

In the normal course of events, we conduct wage and salary surveys to compare our present rate structures with other competitive companies. A question arises as to whether we should set our rates above, below, or on the average of the survey. Experience has shown that salaries above those shown in the survey of comparable companies do not alone attract higher-caliber employes, and that lower-than-average rates do not necessarily turn away good applicants. There are many divergent factors that interplay upon internal labor stability and external labor recruitment. On what basis do we justify our position?

Salaries are costs or operating expense; and like any other operating expense, they must justify themselves. By raising salaries through merit or length-of-service increases, can we justify that we will receive a greater return in terms of more production? Is there increased morale? Has the employe received the increase on the basis of length of service, or because he has

shown sufficient progress through increased ability to merit a raise?

We literally control a fixed cost of millions of dollars, of which we have two responsibilities—one to the employes, to see that they are paid fair and equitable wages; the other to management, to see that it receives a fair return for its money.

Budgetary Control

Many of the above questions can be answered with the use of budgetary control. No wage and salary program is complete without a method of controlling the administration of the merit and length-of-service increases. There are many methods in use today, the predominant one being the allocation of a percentage of a total annual payroll to merit increases, usually between 3 to 5 percent. This amount is usually distributed to the various departments, based on many factors, including total employes in the department, amount of payroll, turnover, etc. Since this is one of the most important phases of wage and salary administration, our company's present method of budgetary control will be described.

Anderson-Prichard uses a method similar to the compa-ratio method developed by Edward N. Hays.

We find that many executives think in terms of maximums and minimums rather than in terms of a normal salary for each job. Yet, in order to maintain a proper cost control, we must think in terms of maintaining an over-all normal consistency.

In administering a wage and salary program, we thought it desirable to have some index of the level of salaries to serve as a guide and such an index is the compa-ratio. When a company has a formal plan of job evaluation such as ours, with rate ranges and definite minimums and maximums, the compa-ratio is an effective method of maintaining expense control.

As the name indicates, compa-ratio is the ratio between actual salary and the midpoint of the salary rate range; and it is used by comparing the salary level against the rate ranges. If the salary and midpoint of the rate range are identical, the compa-ratio is 1.00. Our present rate ranges have an approximate 35 percent spread. With this 35 percent spread, the salary, when at minimum, would have a compa-ratio of 85; at the maximum it would be 1.15.

Compa-ratio for a department is obtained in a simple manner. The sum of all salaries in the department is taken for the numerator of the ratio; the sum of the midpoint of the ranges for all employes is taken for the denominator; the resulting fraction, multiplied by 100, is the compa-ratio. Thus, when the compa-ratio is 1.00, salaries on the average are in the midpoint of the various ranges.

We have found it desirable to keep the compa-ratio around 1.00. When the ratio is around 1.00, it indicates that there are as many employes near the maximum salaries of their respective grades as there are employes near the minimum. Likewise, there will be a good number at, or near, the midpoint. This gives the employe an incentive to do good work. Similarly, it means that the employe is receiving substantially more on the average than the minimum salary, and this indicates that he is paid more than a beginner. If the average salary were permitted to increase too fast to the average maximum of the ranges, the amount of increase that could be awarded in the future would be very small, other than by promotion to a higher salary grade.

Thus, with compa-ratio the average employe gets more than a beginner, which is enough to hold good employes, and has room for a number of additional salary increases before he reaches the maximum.

Effect of Turnover

In some departments where turnover happens to be especially low, the ratio is higher than in the departments where there is more turnover and where the ratio tends to remain below 1.00.

It is only fair to the employe to reward him for good work. Good employes *must* be able to achieve a somewhat better-than-average salary or they will not remain with the company. Rapid turnover can wreck a company since under this condition, experienced employes are always being replaced with green recruits. An important requirement is that all employes receive like treatment.

Poor employes, or those of indifferent value, are not encouraged with too high pay or with too many increases. This group should be eventually eliminated. This is an important point because when we give too many increases to merely average employes, we are imposing rigid and high restraint on good people who, even in poor times, are entitled to consideration.

If we wish to obtain and hold the ablest talent, we feel we must pay fair and equitable wages, but excessive rates are not necessary for competition and tend to produce unduly low turnover. They encourage mediocre people to remain on the job permanently because they cannot do as well any other place. We feel employes must be dealt with equitably and as generously as possible within the limits of cost stability.

Standards for Salaries

Another factor in connection with this program is worth emphasizing. A job evaluation procedure is necessary for the purpose of creating salary standards for all positions. This determines the rate range for each employe. However, as stated above, it does not have any bearing on the exact salary the individual is to receive within the range. It also should be noted that compa-ratio is only the cost level and has nothing to do with total payroll; that is, whether there are too many or too few employes working in a department.

Here are some points worth remembering: No company, however small, can ever afford to have a "hit-or-miss" salary program. A formal, precise system is essential. Such a system must be based on fair treatment of all employes, plus recognizing momentarily the exceptional talents of the few. It should start with a job-evaluation study that determines the monetary value of the job. A salary range is set for the job and the range is sufficiently broad to provide ample reward for outstanding employes. Next, budgetary control is maintained through the use of a system such as compa-ratio. Top management sets the over-all salary budget, while first line supervisors are charged with the responsibility of administering individual salaries. Each employe's salary should be reviewed with him at least once every six months. Never forget that salary is the key factor in employe morale.

* * *

Dehydration of Natural Gas and Light Hydrocarbon Liquids

Part II. Dry desiccant systems. This method of dehydration now finds its use in operations where very low dewpoints are needed.

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A LARGE percentage of the gas dehydrated in this country is processed by dry desiccant systems. In the last several years other systems have been developed which offer greater advantage from an economic standpoint, but this method is still of great value in many applications. The scope of its use has simply narrowed to those operations where very low dewpoints are needed and/or those cases where other systems are subject to serious process limitations.

With the increased use of dehydration systems as a whole, many modifications have been made in the design of dry desiccant units in an attempt to minimize certain of their serious disadvantages. This has resulted in a number of different designs.

As with all systems, it is necessary to consider both the economic and process variables. From a process standpoint alone the designer must consider not only the design of the unit but the desiccant to be used.

Subsequent parts in this series will discuss other methods of dehydration.

A GOOD granular desiccant should have the following characteristics:

1) High drying capacity.
2) Water adsorbed rapidly.
3) A large fraction of the water vapor removed from the gas at varying temperatures, humidities and gas rates.
4) Economical regeneration.
5) Activity retained after repeated regeneration.
6) Little resistance to gas flow.
7) High mechanical strength to resist crushing and dust formation.
8) Cheap, non-corrosive, non-toxic, chemically inert and have a high bulk density.
9) No appreciable change in volume when wet and should not become sticky or liquid.

Solid desiccants may be divided into two classes; those which owe their activity to surface adsorption and capillary condensation, and those which react chemically. The latter group finds little application in the petroleum industry due to process limitations with respect to both their physical properties and regeneration difficulties.

Reaction Type Desiccants

Magnesium perchlorate has a high, or higher, drying efficiency than any other desiccant, with an ultimate capacity of 48.6 percent water by weight. It does not give up water until a temperature of about 275° F. is reached which permits its use at higher temperatures. In drying, it proceeds through three stages of hydration until the hexahydrate, $Mg(ClO_4)_2 \cdot 6H_2O$, is formed at saturation. However, it is unsafe in the presence of organic vapors due to explosion hazards. In addition, regeneration is difficult since temperatures of 400° to 500° F. are required and a high vacuum is necessary to prevent fusion of the crystals. These limitations obviously prohibit its use with natural gas and hydrocarbon liquids.

Barium oxide dehydrates by forming barium hydroxide which is stable up to 1100° F. While this is advantageous from the dehydration viewpoint it makes practical regeneration impossible. Though this material will pick up between 10 and 11 percent water by weight it swells when wet, making it unsuitable for tower operation.

Calcium oxide has also been used because it is cheap, but its capacity for water deteriorates rapidly due to the formation of carbonates on its surface.

Anhydrous calcium sulfate dehydrates both by the adsorption of water and the formation of a hemihydrate, $CaSO_4 \cdot 1/2H_2O$. It has a water capacity of 12 to 14 percent by weight, of which 6.6 percent is represented by the formation of this hydrate. A good drying efficiency is maintained at most temperatures and commercially low dew points are obtained. However, it will stand only a limited number of regenerations which increases the cost of its use even though the initial cost is moderate. Reports show that it will stand about 200 or more regenerations at 400° to 425° F. before replacement is necessary.

The adsorption type desiccants more nearly fulfill the requirements set forth forth for dry desiccants and are consequently used more widely for the dehydration of natural gas. These may be subdivided into two categories; the gel type and the alumina type. Several varieties of each are marketed in this country, all of which vary both in composition and cost. Due to this cost difference it is necessary to balance out the initial cost of desiccant and equipment with the replacement costs involved. The final choice then results from these economic factors with due consideration for the process limitations of each desiccant. In many instances process conditions dictate the choice of desiccant and the initial cost is a minor consideration.

TABLE 1
Properties of the Adsorption Type Desiccants

TYPE OF DESICCANT	Bulk Density, Lb./Ft.	Specific Heat Btu/Lb./°F.	Thermal Conductivity Btu./Hr./Ft. per °F./In.	Type	Normal Mesh Sizes Used	True Specific Gravity	Percent Voids As Packed
Activated Alumina	51	0.24	1.0	Hard Granules	½"—¼" ¼"—8 mesh 8/14	3.9	49†
S/V Suvahead	48	0.25	1.0	Hard Smooth Gel	4/8	2.3	40
Florite	50	0.24	1.0	Hard Granules	2/4 4/8 4/14	3.4	40*
Alumina Gel	45	0.24	...	Hard Spheres	¼"	...	46
Silica Gel	39	0.22	1.0	Hard Smooth Gel	4/8	2.2	50

* 4-8 Mesh. † ¼"-8 Mesh.

The properties of the most common adsorption type desiccants are summarized in Table 1. Of all the mesh sizes shown 4/8 mesh desiccant is most commonly used as a middle-of-the-road compromise. The smaller sizes have a greater potential drying ability per pound but the pressure drop is correspondingly higher. With the larger sizes the reverse is true but the channeling of gas is more prevalent.

As might be expected florite and activated alumina have similar properties, differing primarily in their chemical composition. The alumina gel shown is now in the development stage and is not yet available commercially.

Activated alumina is essentially aluminum trihydrate which has been rendered porous upon "activation" that is carried out at 750° to 800° F. to drive off the necessary water. As shown in Table 2, it is essentially aluminum oxide with minor amounts of other materials. In manufacture it is normally obtained in large pieces as one of the products in the processing of bauxite ore to produce aluminum. Various grades are manufactured, some with additives, but Grades F-1 and F-3 are used in natural gas dehydration.

Under ideal conditions, with cooling coils to remove the heat released upon adsorption, activated alumina will adsorb up to 13 to 15 percent of its weight water. However, in the usual application, when new, 10 to 11 percent sorption is most common. Most reports to date indicate that the drop in capacity, percentage wise, is higher with activated alumina than with other bauxite desiccants. This, at least in part, may be attributed to the formation of an aluminum monohydrate which has little or no adsorptive properties. For some reason the raw bauxites do not form this monohydrate as readily.

Due to its purity activated alumina is superior to bauxite in the dehydration of gases which will react with any impurities in the desiccant. Hydrogen sulfide, for example, will react with the iron in bauxite to form iron sulfide, subsequently reducing desiccant efficiency.

The total volume of voids in a bed of one-fourth-inch 8-mesh activated alumina is usually considered to be about 75 percent, based on 49 percent voids between the particles and 26 percent in the pores. These figures, of course, vary somewhat in the method of filling and size of the particles.

Florite is prepared from special bauxite ore in a manner similar to that used with the other aluminas. As shown in Table 2 it differs from activated alumina primarily in the amount of impurities present. The total void volume is also about 75 percent, with about 40 percent of this between the particles and the remainder in the pores.

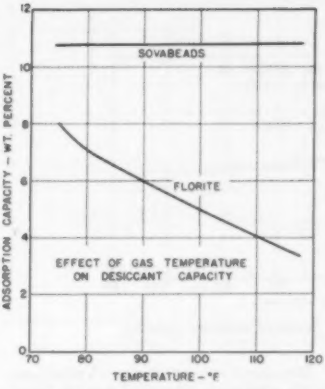

Figure 1. Effect of gas temperature on desiccant capacity.

Adsorption capacities as high as 12 to 15 percent have been reported but in commercial units, with new desiccant, 6 to 7 percent is more common. The rate of decrease of adsorption capacity with time, however, is less percentage wise. Most process designers usually use 4 to 5 percent capacity when Florite is used to dehydrate substantially saturated gas.

Many field reports show that the presence of the impurities, particularly iron, probably has some injurious effects on the adsorption efficiency when processing sour gas. Undoubtedly the concentration of H_2S in the gas has some effect on the degree of this "poisoning." In the presence of oxygen elemental sulfur is deposited.

TABLE 2
Typical Analysis of Alumina Desiccants—Weight Percent

	Activated Bauxite	Activated Alumina
SiO_2	13	0.1
Al_2O_3	74	92
Fe_2O_3	3	0.1
FeO	Trace	.....
TiO_2	1	Trace
H_2O	9	7.0
Na_2O	.....	0.8

TABLE 3
Relative Drying Efficiency of the Common Dry Desiccants

Material	Dew Point—°F.
Silica Gel	—62
Sovabeads	—75
Activated Alumina	—87
Activated Bauxite (Florite)	—87
Magnesium Perchlorate	—96
Calcium Oxide	—95

With all desiccants shown the residual water content is less than 0.1 lb. per MM.

Other activated bauxite materials similar to florite are available, but their properties are similar and warrant no separate discussion.

All granular desiccants "powder" to a certain degree both in handling and in the desiccant bed. There is no positive way of preventing this altogether but it may be minimized by using low gas velocities and downward flow through the bed. Dry desiccant plants using upward flow in all, or a portion of the bed characteristically show relatively high desiccant losses due to the turbulence set up in the top of the bed.

Granular alumina desiccants show a greater resistance to fracturing in the presence of liquid water than the gel type. In fact, aluminas have been used for a buffer near the inlet as a protective agent for Sovabeads.

Sovabead is a high silica material, the principal other ingredient being alumina. Tests on field units show that the adsorptive capacity of new Sovabeads varies from 18 to 25 percent by weight. This wide range of capacities is due not so much to an inconsistency in the desiccant as in the design of the unit. Upon use the desiccant capacity drops rather rapidly at first and then levels out at about 10 percent for a considerable period.

Sovabead does not powder to the same degree as the aluminas but is subject to fracturing when exposed to liquid water. Therefore, extra precautions must be taken near the inlet of the bed. For this reason, a special type of Sovabead, which is stronger structurally and less susceptible to fracturing than regular Sovabead, is recommended for use in the first 10 to 25 percent of the bed at the inlet end. Its adsorptive capacity is high with a saturated gas but the rate of sorption is low.

Some field reports indicate that Sovabead stands up better in sour gas service than the aluminas. However, it is difficult to draw definite conclusions in many cases since each system usually varies, not only in its hydrogen sulfide content but in the other components. Some trouble, for example, is encountered with the CO_2 that is adsorbed and then driven off on regeneration. This CO_2, together with the water, can cause failure of the heat exchanger tubes, particularly where a sharp turn is taken.

Alumina gel is not available commercially at present but it offers promise as another excellent dry desiccant material. This material is substantially pure alumina, with some silica, which may be "balled" into spheres. This shape not only reduces pressure drop but has a high structural strength.

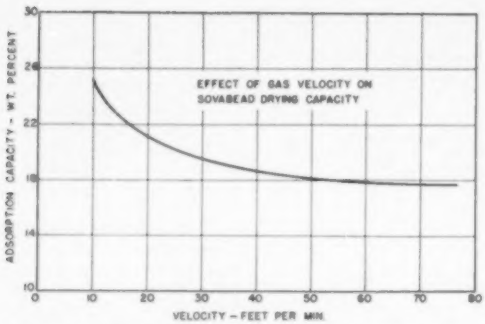

Figure 2. Effect of gas velocity on Sovabead desiccant capacity.

Present tests show it to be equal in adsorptive capacity to Sovabeads. The estimated properties, based on small samples, are included in Table 1.

Although all dry desiccants vary somewhat in the amount of moisture they will remove, they all give gas that is drier than that specified in the natural gas industry. Actually the effective capacity of the desiccant is limited by design rather than equilibrium considerations so that this difference is of little practical importance. Table 3 is a summary of the relative drying efficiency. Tables 4 to 6 summarize other pertinent information about dry desiccants and their use.

Gas Conditions Affecting Adsorption

Temperature.—The effect of the temperature of the gas being dried depends on the type of desiccant used. The alumina type give best results at temperatures below 90° F. for above this temperature the adsorptive capacity falls off rapidly. On the other hand, Sovabeads show no change in adsorptive capacity with temperatures up to 120° F. Some relative data are represented by the curves in Figure 1.[9,12] Since the data shown are for desiccants of different age and in different equipment, the curves are not for direct comparison of capacity but simply to show the trend of each with temperature.

At a given pressure, the higher the temperature the greater is the water content of a gas at saturation. Therefore, the amount of desiccant needed is a function of temperature.

Pressure.—The adsorptive capacity of dry desiccants varies little with pressure. However, the higher the pressure on a gas the less water it contains at saturation. Consequently, the amount of desiccant needed decreases with pressure even though the adsorptive capacity remains constant.

Moisture Concentration.—Variations in the moisture content of the gas have a marked effect on the desiccant adsorptive capacity due to the lower partial pressure (See Part I). In the drying of atmospheric air this is an important consideration. Natural gas, however, is usually substantially saturated which makes this consideration less of a problem. In most instances the relative humidity never drops below 80 percent.

Gas Velocity.—The effective desiccant capacity decreases with an increase in gas velocity as shown in Figure 2.[12] While drying gas, the desiccant bed progressively becomes saturated as the cycle continues. With a given gas velocity the contact time between the remaining unsaturated portion and the wet gas eventually becomes too small to give effective dehydration. Consequently, as the gas velocity is increased, less of the desiccant is effectively used and the overall capacity decreases. In effect then,

TABLE 4
Summary of the Operating Characteristics Dry Desiccant Dehydration

Recommended Operating Range: At temperatures preferable below 125° F. in order to utilize the higher desiccant capacity. The gas should enter the unit above its hydrate point. There seem to be no effective pressure limitations.
Desiccant Service: Normally from one to three years in the absence of poisoning. Service limited by loss of capacity, dusting and breakage.
Dehydration Obtained: Essentially bone dry gas produced (less than 1 pound of water per million standard cubic feet). Most units will give a —30° F. dewpoint during the first part of the cycle.
Length of Cycle: Eight hour cycle most common for convenience although others sometimes used (6, 12 and 24 hours).
Regeneration: Final regeneration temperature varies with type of desiccant, usually 350°-450° F. About 5 to 15 percent of the total gas stream used for regeneration. Normal eight hour cycle uses about six hours for heating, two hours for cooling.
Advantages: 1) Low exit dew point obtained. 2) Gives effective dew point depressions over a wide range of operating conditions. 3) Compact, particularly the smaller units. 4) Relatively low initial investment for small amounts of gas, such as for instruments, where "batch" or "semi-batch" operation is satisfactory. 5) Rated capacity may be increased if some wet gas is by-passed around the unit and recombined with dry gas, where the unit gives an exit dew point lower than that needed or specified. 6) Some operators report additional light hydrocarbon recovery by adsorption on the desiccant.
Disadvantages: 1) High initial investment. 2) Desiccant sensitive to poisoning, particularly from heavy lube oils, which frequently requires expensive desiccant replacement. 3) Rated capacity of the unit declines with pressure. 4) Pressure drop is higher than with liquid desiccant systems. In compressed gas systems this substantially increases the required compressor horsepower. 5) At flow rates below the rated capacity, the regeneration heat load is high in relation to the amount of gas processed.

TABLE 5
Summary of Regeneration Practices

Method of Heating: Usually part of the main stream is by-passed which is either returned to the system downstream or is recombined and dehydrated. Liquefied petroleum gases which have been vaporized or super-heated steam are also used.
Required Temperature: In most instances 350° to 450° F. is recommended. Higher temperatures increase capacity but shorten effective life of desiccant. Majority of water is driven off at 250° F. Gas temperature from heater usually 400° to 450° F.
Direction of Gas Flow: Usually countercurrent to main flow in vertical towers. Other designs often use concurrent flow.
Gas Flow Rate: About 5 to 15 percent of main gas stream. Percentage varies with main gas flow rate and with design of unit. Flow rate must be sufficient to supply the necessary heat in time allotted, for regeneration.
Water Removal: Where regeneration gas recombined with main gas, water from regeneration is removed by cooling with main gas stream or by water cooler. Maximum heat load occurs when bed reaches about 250° F. at which time most of water is coming off. Heat exchanger should be designed for this condition.
Heat Required: Heat of desorption of water plus sensible heat to bring water vapor, desiccant and container up to temperature. Latent heat of water often used for heat of desorption in design.
Time Required: To bring exit regeneration gas up to desired temperature. Usually about 65 to 75 percent of total cycle time.
Pressure: Full line pressure satisfactory.

a consideration of contact time is necessary, thereby introducing gas velocity and bed depth factors.

Specifications vary, but operating experience shows that the gas velocity should not exceed 45 feet per minute in most applications. Most operators prefer the velocity to be between 27 and 45 feet per minute if vertical towers are used. This range is primarily dictated by economic factors since a lower velocity requires such a large diameter. A higher velocity lowers the desiccant capacity and increases the total volume.

The allowable velocity range is broadened somewhat by the use of a horizontal sorber such as that shown in Figure 5. This vessel presents a larger cross-sectional area to the gas flow than a vertical tower of the same dimensions, with a corresponding reduction in velocity.

The time of contact necessary for the complete adsorption of water is quite small, usually less than one-half second. Data for Sovabeads, for example, show 0.41 seconds. Consequently, the total bed depth is not critical as long as it exceeds several feet. Therefore velocity, rather than bed depth, is the factor normally considered for the reasons discussed above.

Contaminants.—The presence of heavy oils in the gas to be dried is of utmost importance since they serve to decrease the desiccant capacity. This form of contamination is most prevalent in those plants located downstream from compressors and processing equipment which exhibit some "carry-over."

Fortunately such contamination is usually concentrated near the inlet although the entire bed is sometimes affected. If the oil is light regeneration removes most of it, but heavy oils, such as lube oil, coke and effectively destroy the desiccant capacity.

TABLE 6
Typical Sieve Analysis of 4/8 Mesh Desiccants Percent by Weight

Sieve Analysis	Florite	Sovabeads
On 4 mesh	1.64	5.9
On 4/8 mesh	90.6	90.0
On 8 mesh	7.76	4.1
On 16 mesh	0.73	...

¼"—8 mesh activated alumina corresponds most closely to 4/8 mesh and normally has the following analysis:
Larger than quarter inch—less than 1 percent.
¼—8 mesh—at least 97 percent.
10 mesh—less than 2 percent.

Mesh Sizes—Tyler Standard Screen Scale

MESH	Opening—Inches
3	0.263
4	.185
6	.131
8	.093
10	.065
12	.055
14	.046

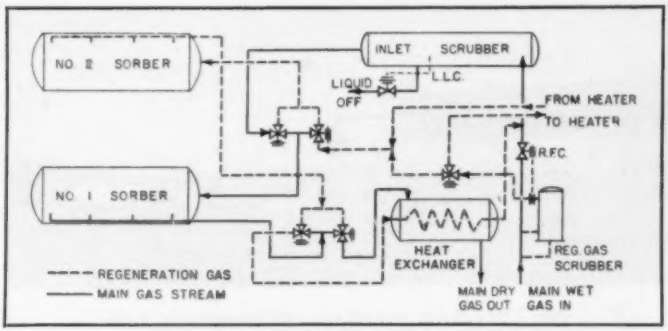

Figure 3. Flow sheet of a natural gas dry desiccant dehydrator.

When such a situation is serious there are several alternatives:

1) Remove the source of trouble—if possible.
2) Use a cheap desiccant, at least near the inlet, replacing it at frequent intervals.
3) Provide some means of pre-scrubbing the gas ahead of the dehydrator.

All of these have been used although the first solution is not practical in most instances. The cheaper desiccants, such as florite, are often used in such situations either alone or in conjunction with another material. Often provisions are made so that the portion of the bed nearest the inlet may be replaced without dumping the remainder.

Frequent desiccant replacement is expensive and time consuming so that some type of pre-scrubber is the most popular solution. Unfortunately many lube oils exist as almost a true vapor and conventional gravity separation methods are inefficient. Probably the best solution is the use of a packed tower ahead of the unit, preferably filled with an adsorptive material. A large surface is thus presented on which the oil may collect.

Since a pre-contactor need not be large, activated carbon has been tried but some operators report that it becomes gummy and difficult to handle. Most operators have had more success using desiccant. This may either be new or that which has been used in the adsorber. When this desiccant becomes saturated with oil it may be partially renewed by washing with gasoline, the oil burned off, or simply discarded. Gas velocities up to 120 feet per minute have been successfully used in beds three feet in depth. The important consideration here is preventing the oil from being blown through the desiccant into the outlet.

In some of the most severe cases the capacity of a bed has dropped to below design figures in a matter of weeks. The authors recently encountered a case in which it dropped to 1.5 percent within two months. If such oil is anticipated, regeneration should be

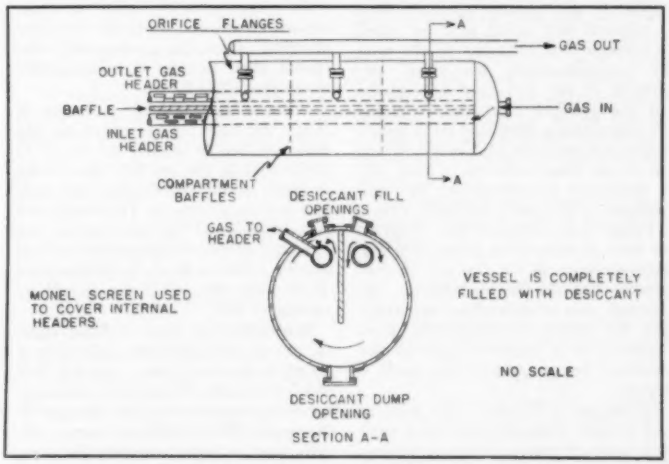

Figure 4. Cutaway view—a horizontal adsorber vessel.

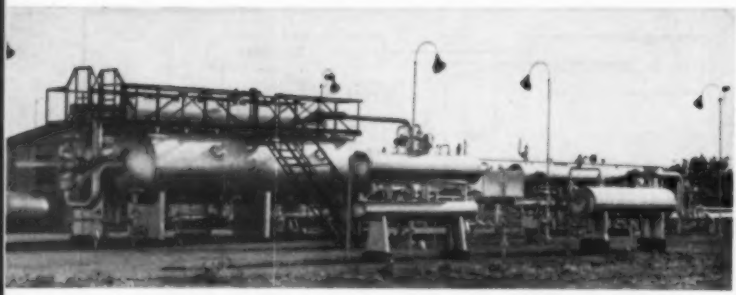

Figure 5. View of a dry desiccant plant with horizontal sorber vessels.

carried out countercurrent to eliminate spreading such contamination throughout the bed.

Equipment Design Factors

Although all dry desiccant plants are similar, there are a number of design differences to be considered since factors such as the methods of regeneration are conditioned by a change in process conditions.

A number of designs are available for the dry desiccant tower itself. The majority of all towers built have been of the conventional vertical type. Some of these use split flow or concentric flow, but the majority are simply a vessel through which the gas passes vertically. Vertical vessels have some serious process limitations such as high pressure drop and lack of flexibility. The former has been reduced by the use of a split flow tower but such towers in the past have shown a high desiccant loss due to dusting, in many cases.

The newest development in tower design is the use of a horizontal sorber with transverse gas flow around a baffle. In this manner pressure drop is reduced and valves may be added to increase the flexibility of the unit. By compartmenting the vessel any portion of the bed may be isolated for low gas flow rates, thus reducing the regeneration heat load more nearly in proportion to the gas passed. Where gas to gas heat exchange is used, this is important in controlling the temperature of the gas to the sales line.

Figure 3 is a typical flow diagram for such an adsorption plant. The flow pattern shown is for the use of concurrent flow on the regeneration gas although two modifications are available to utilize countercurrent flow. Figure 4 is a cutaway view of the adsorber tower proper for such a system.

As shown in Figure 5, this type of unit is skid mounted and comes complete with all inter-connecting piping. This not only reduces the field installation cost but facilitates movement.

Desiccant Design Capacity. — The capacity used for sizing vessels is only 30 to 40 percent of the desiccant capacity when new and is governed primarily by economic factors. The usual capacities used are tabulated in Table 6.

The range of capacities depends on the gas conditions and established company policy. Obviously such design figures must balance out the initial plant cost with that for desiccant replacement. In addition, the use of these lower capacities introduces a safety factor to account for contingencies that cannot be anticipated at the time of design. In the average case most units are designed for five percent sorption when using the aluminas, and 7 to 7½ percent sorption with Sovabeads. However, there are some data to indicate that five percent sorption is also the best figure for use with Sovabeads. In the absence of serious poisoning the desiccant may be replaced less frequently and additional capacity is available for emergencies.

At temperatures above 90° F. lower capacities must be used for the aluminas since, as previously discussed, their activity is substantially lower above this figure.

When a gas-gas heat exchanger is used, the inlet temperature to the desiccant bed is usually 2° to 5° F. above that in the gas line due to the injection of the reactivation gas back into the main stream. The exact rise is a function of the reactivation gas ratio and should be determined in each case by a heat balance. In determining the bed size this small rise should be accounted for.

Dimensions of Tower.—Most vertical tower adsorbers are built with a length-to-diameter ratio between 3:1 and 5:1 in order to maintain a balance between pressure drop and the cost of the vessel. With horizontal towers this ratio may be higher because the pressure drop is not a function of vessel length. The only effective limitation on length is the distribution of gas along a header. However, this is not critical due to the back pressure exerted by the desiccant bed.

Direction of Gas Flow.—With vertical towers downward flow of the gas through the bed is recommended because it reduces desiccant dusting. If upward flow is used, even with proper screens, the upper surface of the desiccant is continually in motion which causes it to powder. During regeneration upward flow is used, but the velocity is small and the dusting action negligible.

In a baffled horizontal bed the gas flows in both directions (see Figure 4). In this case, however, the vessel is packed full and this, plus a lower velocity, prevents abnormal breakage.

Length of Cycle.—The length of the drying cycle is dictated by both economic considerations and operating convenience. Consequently, the most common cycle is eight hours for a two-tower system. Most units are designed for this cycle although 12 and 24-hour cycles are often used, particularly at flow rates well below rated capacity. Even length cycles, which are evenly divisible in 24 hours, are used because most units are automatic and controlled on a time cycle with a 24-hour cam. On manually operated units the length of cycle is normally adjusted to fit operating convenience. Some such plants operate on a 24-hour cycle with regeneration only during the day shift. By this method only a daytime operator is needed.

With four tower systems the cycle length is usually four hours. At any one time two towers are drying with one tower on regeneration and one cooling. This system is normally used in those situations where widely fluctuating flow rates are encountered. It is more expensive, however, than a two-tower system.

Regeneration.—The effective use of a dry desiccant system is contingent upon the successful regeneration of the desiccant. From a control stand-point this is the most critical portion of the cycle inasmuch as sufficient heat must be supplied to drive off the adsorbed liquids and still maintain a good heat balance around the system.

Experience shows that 5 to 15 percent of the total gas must be used for regeneration when operating on an eight-hour cycle, if six hours is allotted for heating and two hours for cooling. With units operating at or near rated capacity, ten percent is a good average. Because about two-thirds of the heat load is represented in heating up the shell and desiccant, at low flow rates the percentage in-

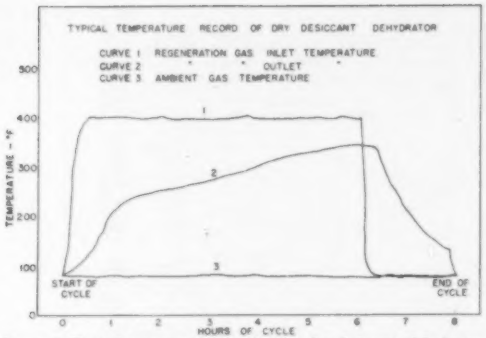
TYPICAL TEMPERATURE RECORD OF DRY DESICCANT DEHYDRATOR
CURVE 1 REGENERATION GAS INLET TEMPERATURE
CURVE 2 " " OUTLET "
CURVE 3 AMBIENT GAS TEMPERATURE
TEMPERATURE - °F
HOURS OF CYCLE
START OF CYCLE
END OF CYCLE

Figure 6. Typical temperature record of a dry desiccant dehydrator.

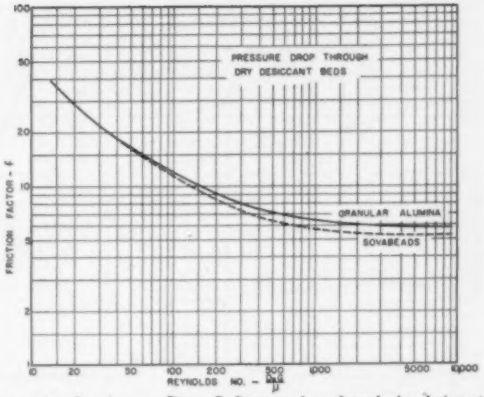

Figure 7. Pressure drop through dry desiccant beds.

creases independently from the water load. The compartmented horizontal vessel offers advantage in this regard since a portion of the bed may be isolated if not needed.

It is desirable to heat the entire bed to 300° to 350° F. on regeneration. A major portion of the water may be driven off at 250° F. but higher temperatures are necessary for any adsorbed hydrocarbons. A typical temperature record is shown in Figure 6.

The heat load during regeneration must be estimated for sizing the heater. This heat load consists of

1) Heat to desorb the water,
2) Sensible heat load for desiccant bed,
3) Sensible heat load of shell,
4) Heat losses.

Many designers use the latent heat of water, but actual data show the heat of desorption to be more nearly 1100 Btu per pound of water. The heat required for the desiccant may be calculated from data in Table 1, while that for the shell must be estimated from the vessel weight. It is customary to add 10 to 20 percent to the sum of the above in order to account for heat losses and add some margin of safety.

Although most units use hot natural gas for regeneration, steam is used in some plant installations. The use of steam is more expensive unless a surplus is available and its use will balance out the heat load on the plant heating system.

Where natural gas is used the most popular method of heating is with a salt bath indirect heater. The salt is a mixture of sodium nitrate, sodium nitrite and potassium nitrate which is a non-corrosive, non-toxic liquid at the temperatures needed for regeneration.[13] The salt is heated by a burner and, in turn, heats the gas in a tube bundle. Additional safety is obtained, over a direct-fired heater, since the gas and fire are separated. Several instances have been reported where direct fired heaters in this service have had tubes burn out with at least partial destruction of this and surrounding equipment. In addition, the flow through the heater is intermittent which lends itself to a heater of this type since it is always hot and can pick up the heat load immediately.

Insulation.—Due to the high temperatures necessary, insulation is a must on the towers and the regeneration gas lines from the heater. In cold climates it is also advisable to insulate the lines from the inlet scrubber to the towers to prevent hydrate formation.

At various times sorber towers have been built using inside insulation, i.e., the insulation is placed between the desiccant and the shell. On paper the idea is good since it reduces the regeneration heat load and supplies the needed insulation. From a practical standpoint, however, its use is at best controversial for it deteriorates in service and becomes of little value. The difficulty lies in the inability to seal it from water which gets behind it and causes deterioration. At present few operators recommend it.

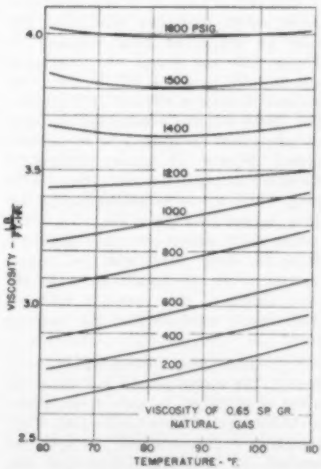

Figure 8. Viscosity of natural gas as a function of temperature and pressure.

Pressure Drop.—The pressure drop through a dry desiccant plant is often critical, particularly if compression is used. Two factors must be considered; the pressure drop in the piping and valves, and that in the desiccant bed proper. That in the bed is the smaller of the two, partially because a pressure drop is taken to force the regeneration gas through the system. The pressure drop in the valves and piping may be estimated from data established by the manufacturers of such equipment.

The pressure drop through the bed may be estimated by the curves in Figure 7. The solid line is for granular alumina desiccants[3, 6] while the dashed line was obtained from data for Sovabeads. The curves do not coincide for previous investigations[4, 9] have shown that pressure drop is a function of the particle surface characteristics. Alumina materials are rough and irregular whereas Sovabeads are smooth gels, which accounts for the slight difference.

The friction factor, f, may be converted to pressure drop by use of the equation

$$\Delta P = 0.0139 \frac{f L G^2}{D_p g \rho} \qquad (1)$$

where: f = dimensionless friction factor,
D_p = effective particle diameter-feet,
g = 32.2 ft. per sec.,²
L = depth of desiccant bed-feet,
ρ = fluid density—pounds per cubic foot,
μ = fluid viscosity—pounds per foot-second,

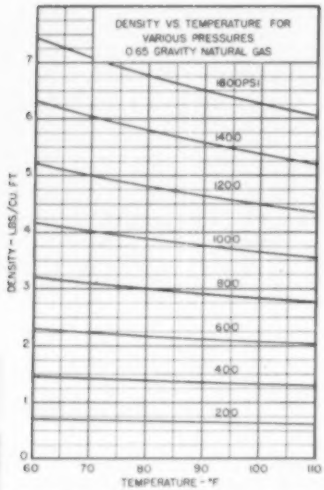

Figure 9. Density of natural gas as a function of temperature and pressure.

G = mass velocity of fluid—pounds per second per square foot,

ΔP = pressure drop in desiccant bed—psi.

The mass velocity, *G*, may be obtained from the linear velocity in feet per minute by the equation

$$G = \frac{V\rho}{60} \qquad (2)$$

where V = gas velocity—feet per minute.

Equation 1, together with Figure 7, may be used to estimate the pressure drop through any size desiccant at any temperature and pressure. The terms ρ and μ vary with temperature and pressure, and may be estimated from Figures 8 and 9.

The term D_p must be determined from the screen analysis of the desiccant and is an average figure. Table 7 shows the size openings for different mesh sizes of the Tyler screen scale, together with typical desiccant screen analyses. The analysis of the desiccant varies slightly with use due to desiccant breakage, so the pressure drop is normally estimated for new material.

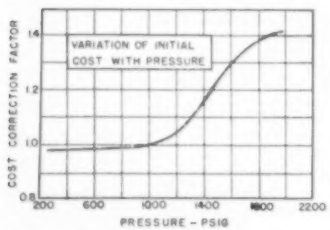

Figure 11. Effect of gas pressure on dry desiccant dehydrator costs.

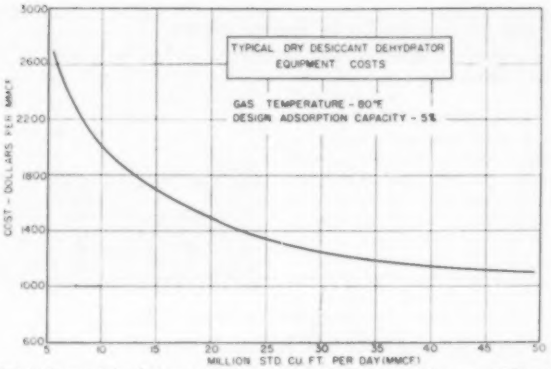
TYPICAL DRY DESICCANT DEHYDRATOR
EQUIPMENT COSTS
GAS TEMPERATURE - 80°F
DESIGN ADSORPTION CAPACITY - 5%
COST - DOLLARS PER MMCF
MILLION STD. CU. FT. PER DAY (MMCF)

Figure 10. Initial cost of dry desiccant dehydrators as a function of gas flow rate (1000 psi W. P.).

If the desiccant breakage becomes severe its life is limited by this factor rather than loss of adsorptive capacity.

Heat Exchanger.—The heat transfer coefficients used in designing the heat exchanger will depend on the method of cooling and the type. The exchanger must contain sufficient area not only to cool the gas but also condense the water vapor present. The safest practice is to assume that all of the water load comes over in about one hour, while the gas temperature leaving the bed is about 250° F. This admittedly will give a slightly oversize exchanger but is has been found to be a good practice. Actually it is not too far from the condition that exists, for the heat load on the exchanger is not constant throughout the heating cycle and reaches a maximum while the water is coming off.

Economic Factors

The initial cost of a dry desiccant plant varies with gas conditions but may be estimated from Figure 10. These data are based on processing gas at 1000 psig and 80° F. with five percent desiccant adsorptive capacity. For seven percent adsorption the cost shown would be from 5 to 10 percent lower. Figure 11 shows correction factors, for pressures other than 1000 psig, which are to be multiplied by the costs shown in Figure 10.

The costs shown are only approximate for they vary with too many factors to be presented on a single plot. However, they serve to estimate costs fairly accurately in the average case.

Operating costs necessarily vary among the many plants but most reports show them to vary from $0.60 to $1.20 per million cubic feet. This variation is due primarily to both the method of charging labor and the individual operating problems.

In comparing over-all economics some consideration must be given to the potential recovery of light hydrocarbons. Some operators report substantial recoveries of such fluids which are driven off by regeneration and scrubbed out.

The cost of desiccant for the initial charge and replacement is an important factor so some consideration should be given to choice. In this case economics is conditioned by process conditions since the lowest priced desiccant is not always cheapest in the long run. No general conclusions may be reached in this regard due to the wide variety of conditions encountered. In fact, the cost factor is no consideration under some circumstances.

Dry desiccant dehydration costs are a relative rather than an absolute quantity since they must be compared with those of other applicable systems, if any.

Dry desiccant systems can seldom be justified on cost alone. This form of dehydration, however, is an important component in the field and is often the best method. For this reason the economics of the system, at best, is a rather nebulous quantity.

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End of Part II. Part III will appear in an early issue.

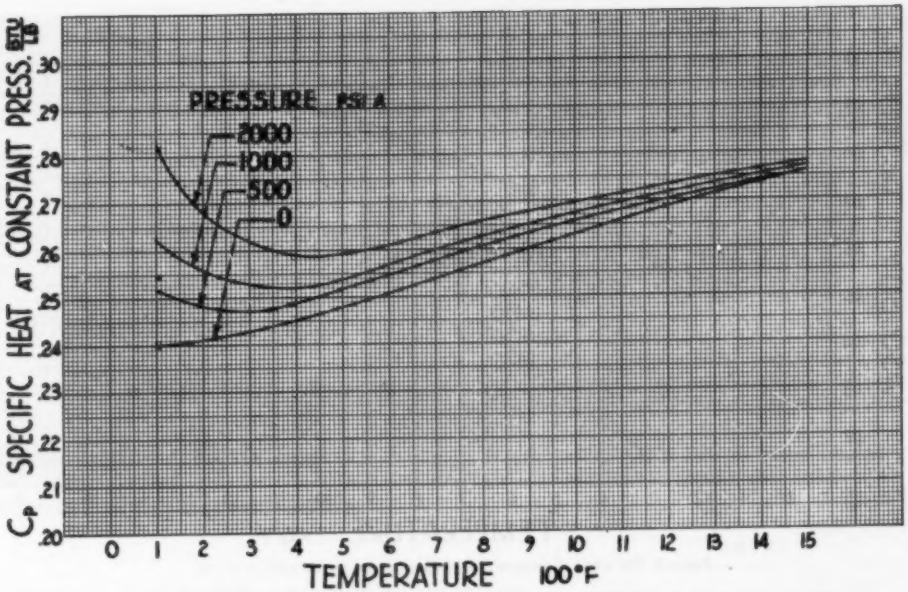

Figure 1. The effect of pressure and temperature on the specific heat of dry air.

The Viscosity, Thermal Conductivity And Specific Heat of Dry Air at Elevated Pressures and Temperatures

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New York

WITH THE advent of higher pressures in industrial operations, the need for accurate information relating to the effect of pressure on the thermodynamic properties of engineering fluids has become increasingly important. Considerable research has been carried out on this subject in recent years, however a great amount of the available data has not been publishd in readily usable form. It is intended here, to present in simplified curve form, data for use in engineering problems involving elevated pressures and temperatures.

In heat transfer work, compression, and transport of gases the design engineer must know the viscosity, thermal conductivity, and specific heat in addition to the other thermodynamic properties. This discussion deals with the transport properties, i.e., with viscosity and thermal conductivity of dry air at high presures and temperatures. In addition, the specific heat of dry air over the same ranges of pressure and temperature is given.

Of the properties covered in this paper, the instantaneous specific heat of dry air is known to the greatest degree of accuracy. The zero or low pressure values can be found in various references,[1, 2, 3, 4, 6,] and the agreement is excellent. For the high pressure values, the data of Ellenwood, Kulik and Gay[4] were used. These values check very satisfactorily with the values calculated from the data of Sage, Lacey, et al.[2] Figure 1 shows a plot of the specific heat of dry air as a function of temperature and pressure. At high temperatures, C_p is almost independent of pressure while at low temperatures there is a marked dependence upon pressure.

The degree of accuracy to which the thermal conductivity and viscosity of dry air are known does not approach that of the specific heat. In order to obtain the values plotted in Figure 2 and Figure 3 it was necessary to use several procedures.

The low-pressure data from references[1, 3, 5, 9] were plotted and the best average curve was determined. This procedure allowed the establishing of the atmospheric curve of viscosity and thermal conductivity. For the determination of the effect of high pressure on these properties the correlations of Gamson[10] and Uyehara and Watson[7] were used. These correlations are based on the Law of Corresponding States[8] and most of the high pressure data available. For dry air, the critical temperature and pressure were respectively taken as —222 F. and 546 psia[4] and the "critical" thermal conductivity and viscosity were taken as .0165 Btu.Hr./Ft/°F. and .0467 lb/ft. hr. (Reference 10 and calculated from the low-pressure plots mentioned above). With these values the viscosity and thermal conductivity were calculated over the desired range and plotted. Figure 2 and Figure 3 show the final smoothed values for these properties. It will be noted that, while the dependence upon pressure is much less than that shown in Figure 1 for

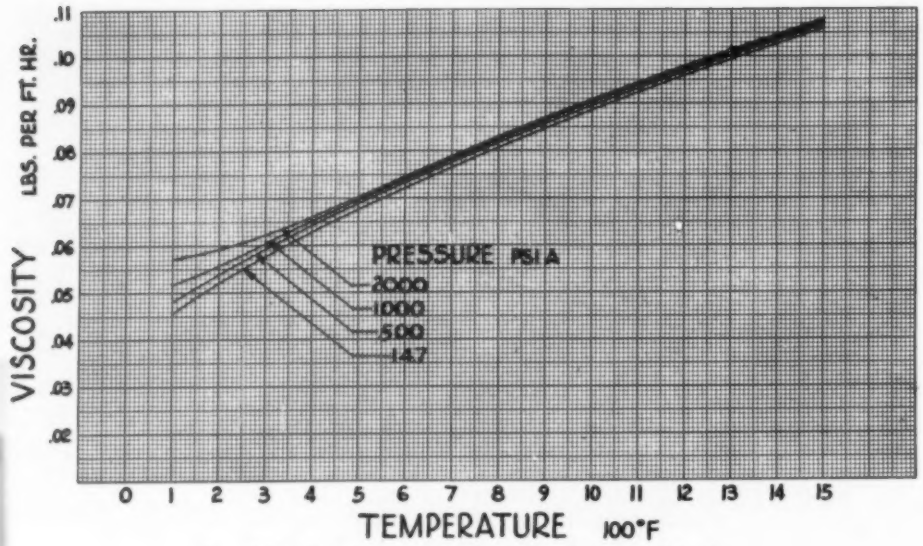

Figure 2. The effect of pressure and temperature on the viscosity of dry air.

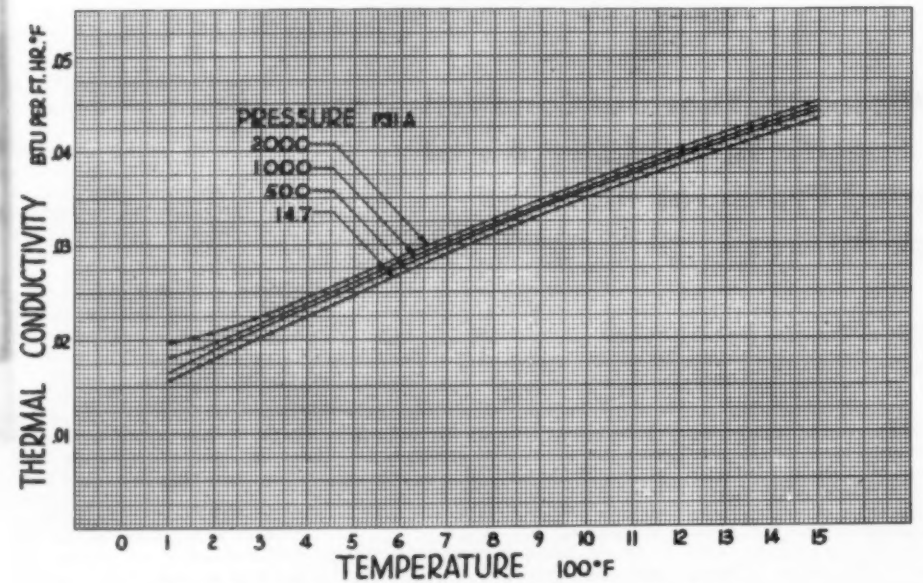

Figure 3. The effect of pressure and temperature on the thermal conductivity of dry air.

the specific heat, the error introduced in neglecting the effect of pressure is appreciable, particularly in the lower temperature range.

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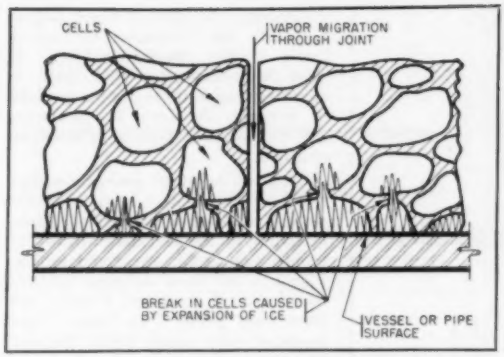

Figure 1. Microscopic section of cellular glass insulation installed on pipe or vessel.

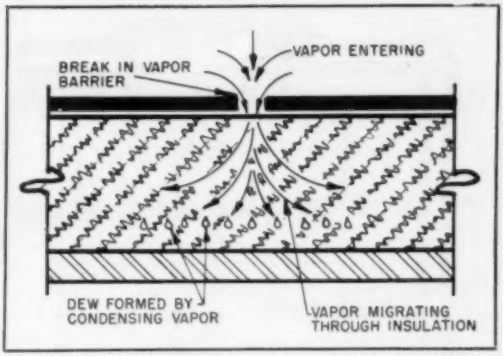

Figure 2. Moisture migration in insulation caused by break or failure of vapor barrier.

Thermal Insulation for Industrial Requirements

Part VII. Specifications and Application of Low Temperature Insulation

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Carbide and Carbon Chemicals Company,
South Charleston, W. Va.

IT WAS STATED earlier in the series that thermal insulation consisted of mass types (granular, cellular and fibrous) and reflective types. Consideration of the mass types in this article will be concluded while emphasizing the care which must be exercised in the application to bring about the greatest benefits. In contrast to the atmospheric and elevated thermal insulation requirements, which may continue to give impaired service even when in a state of partial deterioration low or sub-zero temperature materials must perform unconditionally or suffer an inevitable progressive breakdown. Therefore there is no compromise in the treatment of the low temperature problem with regard to the adherence to sound thermal insulation principles.

As stated previously, any weakness in the thermal resistance of the basic material, must be compensated for in the protective medium whether in the form of a vapor or weather barrier. A thermal insulant with a very high vapor resistance will require less resistance of the barrier than one of low resistance for equal service, but the higher the combined resistance, the better the service and longer the life which can be relied on. For purposes of illustration, cellular glass is used in this article in some instances as being representative of the rigid type materials.

The low temperature operating range of thermal insulation materials is 32° F. and below. This is below atmospheric temperature under almost all conditions, and the vapor pressure of the atmosphere is pressing inward. Consequently, the vapor that enters the insulation is condensed, then frozen into ice, and thus trapped. Therefore the biggest problem of low temperature insulation is to confine the moisture at the outer surface and restrict it from entering the insulation.

The insulation most suitable for the particular installation being considered will, owing to the requirements of the installation, be manifest to the insulation engineer. Likewise, discernment will enable him to select a vapor barrier or weather barrier which is most suitable. However, the vapor barrier and weather barrier must function as a unit to protect the insulation so that care must be taken that each can be used with the other. For example, a vapor barrier which is hard and brittle, no matter what its other characteristics are, cannot be used properly with a soft, pliable insulation.

Table A offers a list of commonly used insulating materials which are generally suited for use in the low temperature range.

TABLE A

MATERIAL	Approx. Upper Temp. Limit
Mineral Wool molded with asphalt binder	150° F.
Felted cattle hair	250° F.
Vegetable Cork	250° F.
Glass fibers molded with binder	600° F.
Cellular Glass	800° F.
Mineral Wool Blanket	600° F.

The minimum temperatures which these materials will withstand is generally limited by the vapor seal which can be obtained to keep them dry.

Vapor and weather barriers may be of metal films, bituminous impregnated felts, plastic films, plastic coatings, or mastic coatings. The plastic or mastic coatings may require a reinforcing membrane of metal, fabric, tape or cloth to augment their tensile strengths. It must be remembered that when metal or felts are used their effectiveness is no greater than the seal obtained by their joints. In many instances the most effective installation is obtained by using a combination of barriers. Frequently, for example, a sheet barrier is used on smooth even surfaces whereas a mastic or plastic coating is used on adjacent irregular surfaces.

After selection of the insulation and its barriers has been made, specifications for its application must be written. To obtain proper application it may be necessary to make sketches or drawings indicating the method by which the vapor barrier is to be applied and sealed off. The methods used to obtain seals around valves, flanges, projections, etc., are important for the successful operation of the insulation. Good low temperature application is the fine art of the insulator's craft and

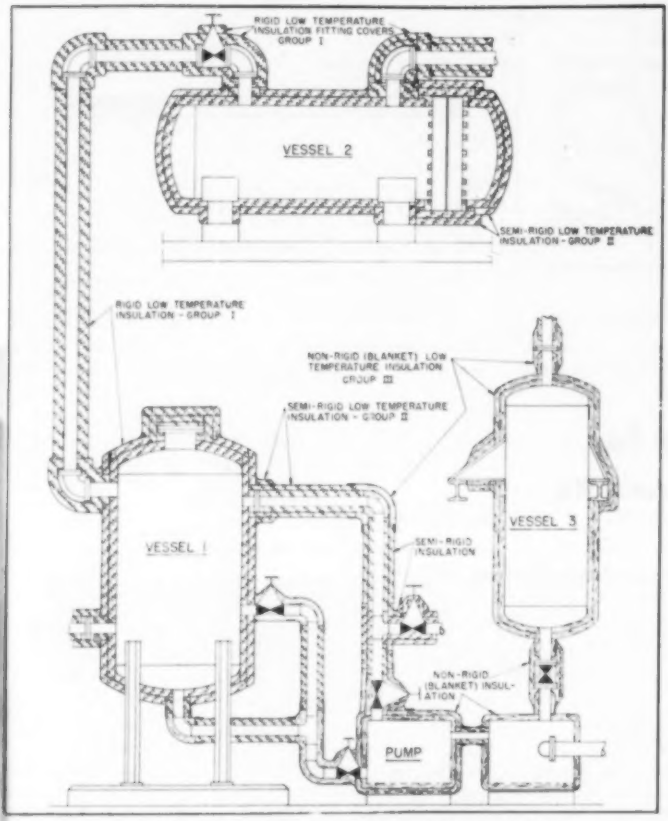

RIGID LOW TEMPERATURE INSULATION FITTING COVERS GROUP I
VESSEL 2
SEMI-RIGID LOW TEMPERATURE INSULATION - GROUP II
RIGID LOW TEMPERATURE INSULATION - GROUP I
NON-RIGID (BLANKET) LOW TEMPERATURE INSULATION GROUP III
SEMI-RIGID LOW TEMPERATURE INSULATION - GROUP II
VESSEL 1
VESSEL 3
SEMI-RIGID INSULATION
NON-RIGID (BLANKET) INSULATION
PUMP

Figure 3. Schematic Details of Typical Equipment, Pump, and Piping.

like all fine arts it becomes a matter of careful attention to the smallest detail.

Specifications

As in all specification it is first necessary to name and describe the insulation (or insulations) to be used. Likewise the weather barrier, vapor barrier and accessory materials should be named and described, specifying the important characteristics desired in each.

Fundamental low-temperature insulation may be divided into three groups. Each of these must be applied in a manner most suited to its particular nature. These three groups:

I) Rigid insulation with a vapor resistance equal to any barrier which may be applied to it.

II) Semi-rigid insulation with partial vapor resistance, but dependent upon additional vapor barriers.

III) Non-rigid insulation with little vapor resistance which depends upon a vapor barrier for its vapor resistance.

In Group I few cellular materials are produced, at this time, having such a high vapor resistance that a vapor barrier is apparently not required. However, due to certain limitations they do require vapor protection. As shown in Figure 1, vapor which enters the joint between blocks will arrive at a point where it condenses in the half cells formed when the block was cut. This condensate will freeze and cause a fracture of the cell wall, allowing the moisture to enter other cells. Although this process is sometimes very slow it could eventually ruin the insulation. For this reason, and to prevent abrasion between the blocks, the joints should be sealed with a material, which not only prevents the vapor from entering, but also fills the half cells to prevent them being filled with moisture.

All materials in Groups II and III rely upon a vapor membrane to prevent vapor from entering their surface and eventually causing failure. Figure 2 illustrates the effect of vapor migration into the insulation through a break in the vapor membrane. It must be remembered that there is vapor migration through even the best of barriers, therefore the insulation will eventually become affected by moisture.

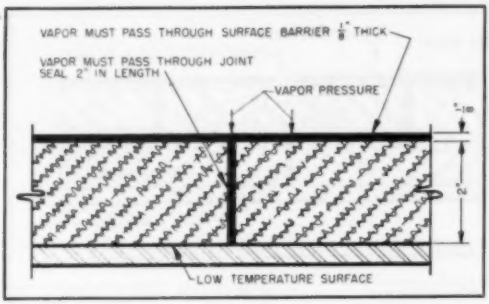
Each of the three groups requires a different method of application for weather and vapor barriers so, again referring to the schematic details of typical equipment, pump and piping, Figure 3, the three different methods are illustrated. As shown, Vessel 1 and lines from Vessel 1 to Vessel 2 are insulated with rigid, vapor resistant insulation (Group I). Vessel 2 and lines from Vessel 1 to the pump are shown with semi-rigid, partly vapor resistant insulation (Group II). Vessel 3, the pump and the line between are shown with non-rigid (blanket) insulation (Group III).

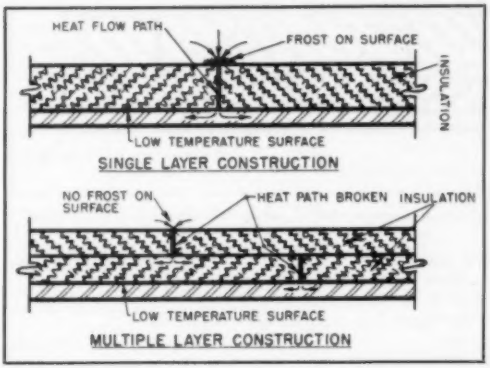
Equipment

Group I—Material

Not all cellular type insulating materials are equally vapor resistant, but even those materials which may be as resistant as any vapor barrier, still must be protected against moisture and its freezing in the exposed half cells. This is accomplished by filling the half cells with a sealing compound which will not freeze or become brittle at the lowest temperature of operation. Asphalt base materials can, in general, be used for this service down to —50° F. Below this temperature special compounds are necessary. In addition to sealing the half cells the sealing material must also have the property of reducing abrasion where necessary between the butted edges of insulation blocks. To obtain all these properties in one material may be impossible and in this case a higher vapor migration rate can be tolerated because the joint is of small exposed outside area. Since the seal is between two vapor resistant blocks of insulation, the rate of vapor transmission is determined by the length or depth of the vapor seal and not its thickness as in the case of most vapor barriers. This is illustrated in Figure 4.

For the reasons given above it is apparent that the success of any installation depends upon the use of the proper joint material, or materials. These materials should be specified with care to make sure that errors do not occur. Of course, the specifications should list the weather and vapor barrier, securement materials, and all accessories. Each should have their properties sufficiently described to prevent use of the wrong material.


VAPOR MUST PASS THROUGH SURFACE BARRIER 1/8" THICK
VAPOR MUST PASS THROUGH JOINT SEAL 2" IN LENGTH
VAPOR PRESSURE
LOW TEMPERATURE SURFACE



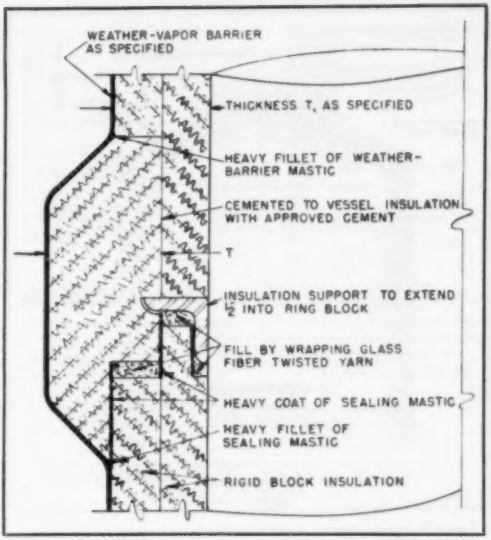

WEATHER-VAPOR BARRIER AS SPECIFIED
THICKNESS T, AS SPECIFIED
HEAVY FILLET OF WEATHER-BARRIER MASTIC
CEMENTED TO VESSEL INSULATION WITH APPROVED CEMENT
T
INSULATION SUPPORT TO EXTEND 1/2 INTO RING BLOCK
FILL BY WRAPPING GLASS FIBER TWISTED YARN
HEAVY COAT OF SEALING MASTIC
HEAVY FILLET OF SEALING MASTIC
RIGID BLOCK INSULATION

Figure 4 (top left). Comparison of length of vapor travel through surface vapor barrier and joint seal.

Figure 5 (above). Rigid insulation contraction joint for low temperature vessel.

Figure 6 (lower left). Comparison between single and multiple layer insulation construction.

Group I—Application

Cellular glass is unique in that it is rigid. For this reason it is most important that the material be fit closely and the joint be made just as thin as possible. The mastic seal used in the joints should be applied as thinly as possible. Applied on equipment of any great length, contraction joints must be provided, as the low temperature metal will shrink more than the cellular glass which, at the best, is at some higher mean temperature, and whose surface is approximately at atmospheric temperature. A typical method of fabricating such a contraction joint is shown in Figure 5.

Where operating temperatures are sufficiently low to require thick insulation, better results can be obtained by the use of multiple layer construction with broken joints, than can be obtained by single layer construction. As shown in Figure 6 this method of construction breaks the heat paths and thus reduces the possibility of frost forming at the joints on the outer surface.

Weather and vapor barriers on outer surfaces of insulation must be chosen with care. They must fulfill all requirements placed upon them by the installation and must serve the purpose of protecting the insulation from abuse, weather, water and vapor. Selection of the proper weather-vapor barrier is one of the most important steps in the specification of a low temperature insulation application. No better service can be expected from the insulation than can be expected from the barrier that protects such insulation. An inferior vapor barrier or a poor application of a good barrier, results in an early breakdown of the insulation. Because of the many factors involved in determining the best barrier, further detailed discussion will not be considered at this time.

The matter of securement has been previously discussed and will not be further discussed in this article. It is important, however, that, where multiple layer construction is used, every effort be made to stagger the joints wherever possible. A typical low temperature vessel with head insulation and nozzle insulation is shown in Figure 7. Notice how the joints are broken at the junction of the head insulation with the side wall and at the junction of the nozzle insulation with the head insulation.

Groups II and III—Materials

These two groups are combined in the specification because they are so frequently used together in the insulation of low temperature equipment. Each may require its own method of securement; for example, semi-rigid blocks are most frequently wired or strapped in place whereas most blankets are generally secured with twine or tape. Each may require a different type and application of weather and vapor barrier, but if proper barrier stops and interlocking seals are provided the needed protection will be accomplished.

The materials in both these groups depend upon the vapor barrier to restrict the vapor from entering their structure and ruining their insulation value. For this reason it is well to divide any large area so insulated into sections, with each section sealed from adjacent sections. This will confine any failure of the vapor barrier with a consequent loss of efficiency, to the affected section and will prevent the ruin of the entire area. This is illustrated in Figure 8.

Groups II and III—Application

Semi-rigid block insulation should be carefully fitted and secured in place with wire or strap as required. Wire or strap used should be rust resistant and if there is danger of galvanic action means should be provided to protect the vessel from electromotive currents. Semi-rigid insulation should be provided with frequent intermediate vapor barriers. Blankets should be carefully fitted and securely held in place with the securement me-

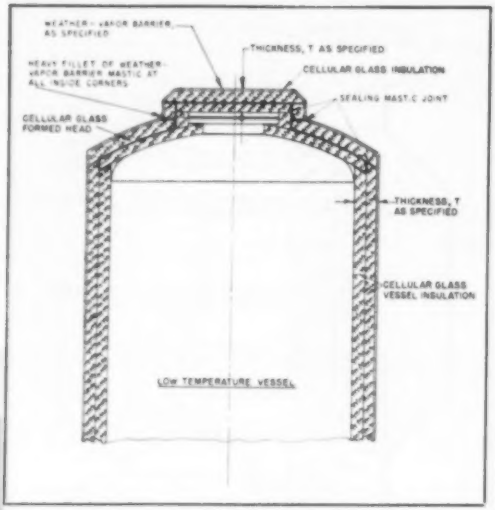

WEATHER-VAPOR BARRIER AS SPECIFIED
THICKNESS, T AS SPECIFIED
HEAVY FILLET OF WEATHER-VAPOR BARRIER MASTIC AT ALL INSIDE CORNERS
CELLULAR GLASS INSULATION
SEALING MASTIC JOINT
CELLULAR GLASS FORMED HEAD
THICKNESS, T AS SPECIFIED
CELLULAR GLASS VESSEL INSULATION
LOW TEMPERATURE VESSEL

Figure 7. Application of rigid insulation to low temperature vessel.

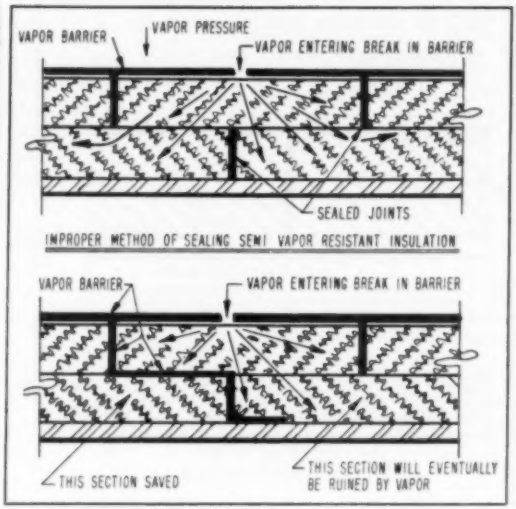

VAPOR BARRIER
VAPOR PRESSURE
VAPOR ENTERING BREAK IN BARRIER
SEALED JOINTS
IMPROPER METHOD OF SEALING SEMI VAPOR RESISTANT INSULATION
VAPOR BARRIER
VAPOR ENTERING BREAK IN BARRIER
THIS SECTION SAVED
THIS SECTION WILL EVENTUALLY BE RUINED BY VAPOR

Figure 8. Proper method of sealing semi-vapor resistant insulation.

dium on close centers. Vapor barriers should be placed on the number of intermediate layers of blanket insulation according to its resistance value and in all cases on the next to outer layer and the outer layer. The vapor barrier over blankets should extend over the adjacent vapor barrier of the block insulation for a minimum distance of three inches to obtain a complete seal. In many instances the outer layer of blanket may be covered with 4-inch wide friction or similar tape to add strength and smoothness to the blanket surface. Friction tape by itself is a poor vapor barrier so it must be coated with an approved vapor resistant material. Many good vapor resistant coatings do not adhere well to closely woven tape; thus it is often necessary to reinforce the vapor barrier coating used over tape.

A typical low temperature installation using semi-rigid block insulation for the body and blanket insulation on the heads and nozzles is shown in Figure 9. This figure shows how the blanket insulation may be completely isolated from the block insulation by a barrier. It also shows the recommended location of the vapor barriers in the blanket insulation. Blanket insulation over nozzles, etc., should be tapered into head or body insulation so that sharp inside corners are eliminated.

Application—General

In the application of low temperature insulation the most serious common error is in the vapor and weather barrier application to corners. More breaks occur on inside corners than at any other points of the application. The second most important point is sharp outside corners which are subjected to bumps, etc. Most low temperature equipment is subject to vibration, and all is subjected to contraction. These forces cause stresses on the outer weather-vapor membrane. In

Figure 9. Application of semi-rigid and blanket insulation to low temperature vessel.

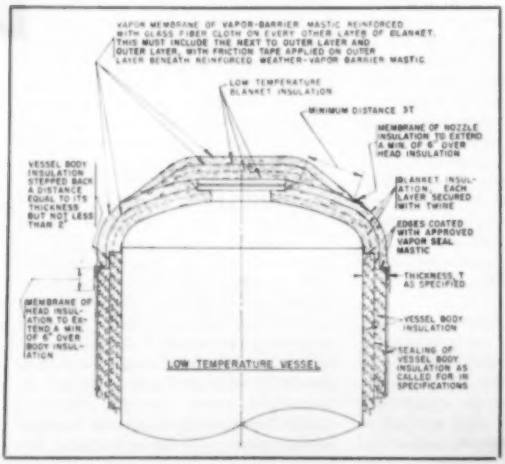
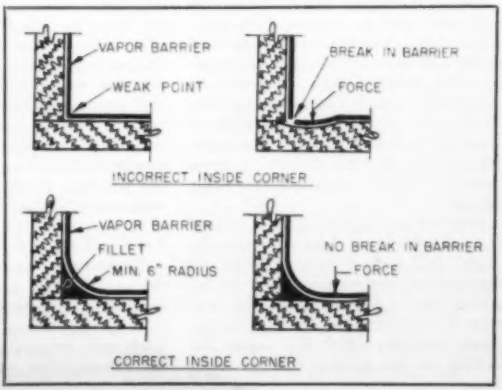

VAPOR MEMBRANE OF VAPOR-BARRIER MASTIC REINFORCED WITH GLASS FIBER CLOTH ON EVERY OTHER LAYER OF BLANKET. THIS MUST INCLUDE THE NEXT TO OUTER LAYER AND OUTER LAYER, WITH FRICTION TAPE APPLIED ON OUTER LAYER BENEATH REINFORCED WEATHER-VAPOR BARRIER MASTIC
LOW TEMPERATURE BLANKET INSULATION
MINIMUM DISTANCE 3T
MEMBRANE OF NOZZLE INSULATION TO EXTEND 'A' MIN. OF 6" OVER HEAD INSULATION
VESSEL BODY INSULATION STEPPED BACK A DISTANCE EQUAL TO ITS THICKNESS BUT NOT LESS THAN 3"
BLANKET INSULATION EACH LAYER SECURED WITH TWINE
EDGES COATED WITH APPROVED VAPOR SEAL MASTIC
THICKNESS, T AS SPECIFIED
MEMBRANE OF HEAD INSULATION TO EXTEND A MIN. OF 6" OVER BODY INSULATION
VESSEL BODY INSULATION
SEALING OF VESSEL BODY INSULATION AS CALLED FOR IN SPECIFICATIONS
LOW TEMPERATURE VESSEL

Figure 10. Application of vapor barrier to inside corner.



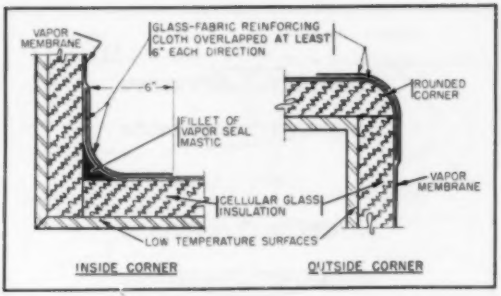


Figure 11 (above). Installation of vapor barriers at corners.

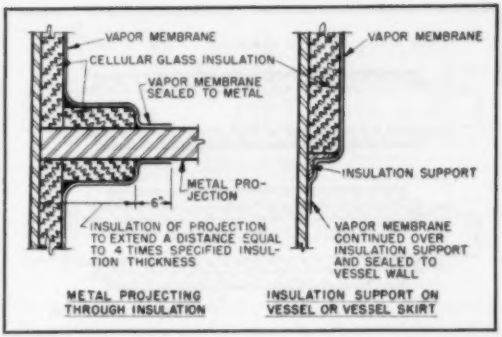

VAPOR MEMBRANE
CELLULAR GLASS INSULATION
VAPOR MEMBRANE SEALED TO METAL
METAL PROJECTION
6"
INSULATION OF PROJECTION TO EXTEND A DISTANCE EQUAL TO 4 TIMES SPECIFIED INSULATION THICKNESS
METAL PROJECTING THROUGH INSULATION
VAPOR MEMBRANE
INSULATION SUPPORT
VAPOR MEMBRANE CONTINUED OVER INSULATION SUPPORT AND SEALED TO VESSEL WALL
INSULATION SUPPORT ON VESSEL OR VESSEL SKIRT

Figure 12 (above, right). Insulation of vapor barriers where metal extends past insulation.

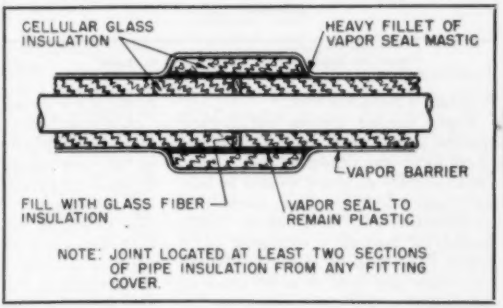

CELLULAR GLASS INSULATION
HEAVY FILLET OF VAPOR SEAL MASTIC
VAPOR BARRIER
FILL WITH GLASS FIBER INSULATION
VAPOR SEAL TO REMAIN PLASTIC
NOTE: JOINT LOCATED AT LEAST TWO SECTIONS OF PIPE INSULATION FROM ANY FITTING COVER.

Figure 13 (right). Contraction joint for cellular glass insulation.

addition, the outer weather-vapor membrane is subjected to external abuse. The corners being most generally the weakest points often account for the beginning of failures. Figure 10 illustrates this condition and a means of correction by using fillets in inside corners. In addition to using fillets to round out inside corners, double reinforcing is also recommended. Most sheet materials or felts do not lend themselves well to placement on inside and outside corners so for this purpose a vapor-weather barrier mastic is most effective. Because most mastic materials have relatively little tensile strength, a suitable reinforcement is required. The method of application to obtain this reinforced seal is shown in Figure 11.

Metal projections through the insulation are another problem which always presents itself in the insulation of low temperature equipment. Although mentioned in previous articles, it is restated because of its serious nature. The metal projections must be insulated for a sufficient distance beyond the surface of the insulation to prevent the formation of ice where they emerge from the insulated surface. To obtain proper results, the distance the projected metal is to be insulated should be determined by the heat gain of the metal, balanced by the proper thickness and length of insulation, so that its temperature at the point where the insulation stops will be approximately the same as the surface temperature of the insulation. In most cases calculations necessary to obtain these results for all projecting metal would be too time consuming to justify the savings. In addition, field conditions are such that the thermal insulation in few cases could be applied. For these reasons a rule of thumb is used which requires insulating projections a distance of four times the thickness specified for the equipment. Extreme care should be taken to seal the outer weather-vapor barrier of the projection insulation to the metal where the insulation ends. Details of these conditions are shown in Figure 12. Also illustrated on this sketch is the method of continuing the membrane over and beyond any supporting angles. These are seldom welded to a vessel or vessel skirt with a continuous weld and unless the seal is made below the angle a vapor leak will occur beneath the angle.

Piping Specifications

Group I—Materials

This specification for piping should, as is done for equipment, specify the materials to be used, their composition and their properties. In addition, it should list the sizes to be furnished in sectional pipe insulation, segmental pipe insulation and, if desired, preformed fitting covers.

Group I—Application

The pipe insulation should be applied to piping in staggered position, with all joints tightly butted and buttered with specified joint cement. Where expansion and contraction movements or excessive vibration is present, the inner surface of the insulation should be treated with a specified abrasion resistant coating.

Multiple layers, where used, should have each additional layer applied in the same manner as the first layer, but so placed that the side and end joints will be staggered with reference to joints of preceding layer so that no two joints will coincide except where they cross at right angles. Again, if determined necessary by the installation, a thinly buttered coating of abrasion resistant material may be required between the layers of the rigid insulation to seal the half cells on the surface, in order to prevent failure owing to ice formation or excessive wearing.

Layers of the pipe insulation shall be secured with wire or strap to conform to necessary requirements.

Fitting covers should be fabricated of the same material and thickness as the material specified for the pipe insulation. They should be carefully fitted around fittings with inner surface and joints treated in same manner as specified for the pipe insulation.

Contraction of low temperature lines must be compensated for in the application of the low temperature insulation on long straight runs of pipe. Cellular glass rigid insulation will not compress to take up the contraction of the lines, so properly spaced contraction joints must be provided. Shown in Figure 13 is one type of contraction joint which may be used.

The application of the vapor barrier must conform to the vapor barrier specified.

Where factory attached vapor barrier jacket is furnished with pipe insulation, laps of jacket should be buttered with recommended sealing cement and carefully pressed in place

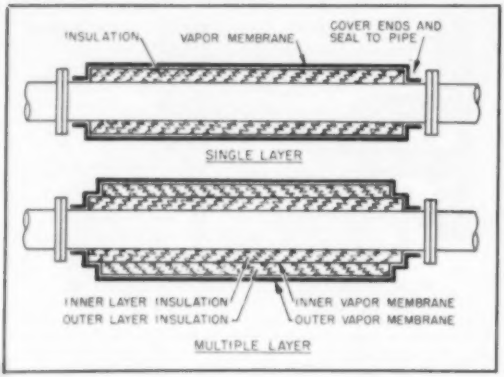


Figure 14. Vapor barrier sealed metal to metal.

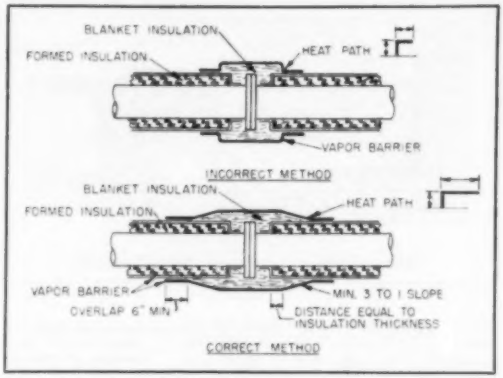


Figure 15. Application of vapor barrier to line flange.

to obtain a complete seal.

Vapor barrier jackets not factory applied to the pipe insulation should be cut to fit with minimum 3-inch laps. Entire surface of jacket should be buttered with suitable sealing cement. Circumferential and longitudinal joints should be lapped a minimum of 3 inches. Laps must be carefully pressed into place and held firm by hand or mechanical means until cement has set.

When vapor barrier mastic is used it should be sprayed, troweled, or brushed on; to its proper thickness. If reinforcement is used, the reinforcing should be stuck to the insulation surface by its own adhesive, or embedded in the still tacky first coat of mastic. Care must be taken that the reinforcing material is stretched taut and that all joints are overlapped a minimum of 3 inches. When the first coat of mastic is almost dry to the touch, the second coat should be applied by spraying, troweling or brushing to its specified thickness. Finished coat should present a uniform, unbroken, smooth surface with no portion of the reinforcing visible on the finished surface.

Group II—Materials

The specified materials should be listed and described in the same manner as for Group I materials.

Group II—Application

The pipe insulation should be applied to the piping in staggered position, with all joints tightly butted, and secured with wire or strap whichever is most desirable. If multiple layers are specified, it is recommended that each layer be provided with a vapor barrier before the next layer of insulation is applied. Whichever type of barrier is used, it is of utmost importance that the barrier be free of cracks, holes, open joints, or thin spots which might allow access for the vapor.

Additional layers of pipe insulation should be applied with staggered joints in the same manner as outlined under Group I—Applications.

Weather-vapor barrier on straight pipe should be installed in sections before the application of fitting and valve insulation. Each section should be completely sealed within itself by extending the vapor barriers over the butt end of the pipe insulation to the metal piping. Thus any leaks in the vapor membrane of adjacent fitting or pipe insulation is prevented from ruining more than one section of insulation. Stated in another way, it will prevent moisture leak at one location from travelling along the line. This method of sectional sealing is shown in Figure 14.

Group III—Materials

The insulation furnished in this group is the non-rigid or blanket form. The type of blanket to be used and its density as received must be specified. This insulation is secured in place with twine and tape and the properties desired in each of these should also be specified. The vapor and weather barrier mastics must be described and the physical properties required must be listed. Any vapor or weather mastic used with blanket insulation should be elastic after it has dried because most blanket insulation will compress considerably under pressure.

Group III—Application

The blanket should be applied evenly and uniformly about the surface and be secured in place with specified twine wound spirally about each layer on approximately one-inch centers. Joints must be staggered at least two inches from joint immediately underneath. Alternate layers of blanket insulation should be sealed with a vapor barrier. It should be repeated here that ordinary 4-inch wide friction tape, in itself, is not a vapor barrier. In all cases the next to outer layer of blanket should have a vapor barrier. Likewise the outermost surface must always have a vapor barrier, and if additionally needed it should also have a weather barrier.

Pipe insulation should be stopped short of flanges and fittings, with succeeding layers of blanket, if any, stepped back from the end of the preceding layer. All vapor barriers applied to the layers should be brought over the butt ends of the insulation and carefully sealed to the metal pipe, in a manner similar to that shown in Figure 14.

Fitting insulation should be applied after the pipe insulation and in a similar manner. Where the fitting insulation joins the pipe insulation, the blanket should be tapered in such manner as to eliminate, in so far as possible, any acute angles or sharp inside corners. Sharp inside and outside corners are, as in equipment insulation, the greatest source of fractures which cause the deterioration of low temperature insulation to take place by allowing vapor to penetrate inward. It is recommended that all corners which cannot be eliminated, be reinforced as shown in Figure 11. A typical method of applying blanket insulation to fittings is shown in Figure 15.

Application—General

In many cases insulation of two or more material groups are used in the same installation, with no particular difficulty experienced by such use. The most important factor is the placement, sealing off, and completeness of the vapor barriers. If the vapor barriers have sufficient resistance to vapor migration and are properly applied, satisfactory service can be ob-

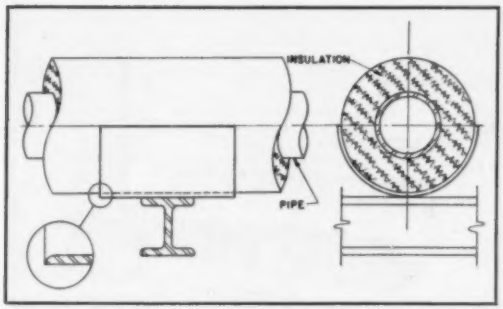


Figure 16. Cradle for insulated low temperature pipe.

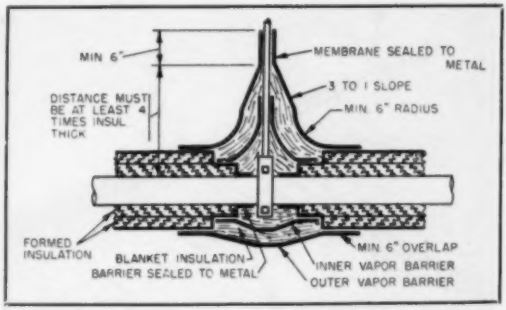


Figure 17. Location of vapor barrier on typical blanket insulation of hanger rod.

tained from any of the insulation groups.

In every case where it is possible, piping operating at low temperatures should be supported on cradles placed outside the insulation. These cradles should be sufficiently large to spread the compressive force, supporting the line, over enough insulation area to prevent undue deformation of the insulation. In addition, the metal cradle should be of such thickness that it is strong enough to resist buckling at the point of support, but also sufficiently flexible to prevent the edges from causing a shearing action cutting into the insulation. Typical cradle is shown in Figure 16.

Where exterior cradles cannot be used, hangers which attach directly to the pipe, having rods which extend through the insulation must be insulated as described for metal projections on equipment. The hanger rod should be insulated for a minimum distance of four times the specified thickness of the insulation. Figure 17 illustrates such a hanger rod insulated with blanket. Any insulation may be used as long as the important membrane seals are provided.

One of the most costly and difficult factors to overcome in an attempt to obtain good insulation application is that of pipe spacing. Many piping designers do not recognize the importance of leaving sufficient clearances for the proper application of insulation. In job after job the clearances left between pipe and vessels are insufficient to allow the insulators to do a good job. The most unfortunate thing about this is the fact that the service life of low temperature insulation depends upon the outer vapor membrane, and in tight spaces it is frequently almost impossible to apply a leak-proof membrane.

Low temperature equipment is most frequently designed with flanges and nozzles located so close to the body that inadequate space is available for proper sealing and tie off. Likewise, low temperature valves are made with bonnets which cannot, as designed, be insulated and vapor sealed with any degree of satisfaction.

Inspection

Field inspection of low temperature insulation requires a constant check of all phases of the application with particular attention being paid to fitting of the joints and installation of the vapor barrier. Each vapor barrier or seal on each layer should be inspected to determine its completeness before the next layer of insulation is applied. Particularly close attention must be given to inside corners, junction of materials, joints, projections and under surfaces, to detect faults in sealing. The detection and correction of one small crack may save hundreds of dollars of insulation in a short space of time.

Maintenance

The maintaining of the weather-vapor barrier on the outer surface of the insulation and sealing all cracks, holes or breaks is the most important factor in the life of low temperature insulation.

End of Part VII. Part VIII will appear in an early issue.

New Distillation Tray Points to Increased Refinery Capacities

A new device "that greatly increases, at low cost, the capacity of petroleum refineries," is now offered under a license to the oil industry by Shell Development Company.

Known as the "Turbogrid" distillation tray, the device consists of an open-grid structure of simple design, for installation in fractionating columns and, according to M. E. Spaght, Shell Development president, they are "the first basic improvement in distillation trays in a quarter-century."

"Widespread use of the new trays will markedly reduce the capital cost of petroleum refining installations, lengthen the useful life of refinery fractionating towers, and increase the industry's capacity," he said.

"The most common tray in use today is the bubble-cap tray, which is a complicated structure of mushroom-shaped bubble caps on a flat plate provided with an overflow "downcomer," Shell said.

"The new Turbo-grid tray is by comparison an extremely simple device. In one form, it consists of little more than a sheet of metal stamped with parallel slots of proper width and spacing. Its success, however, is due to long and painstaking research and experimentation. The area, width and spacing of the slots, the position of the trays in the tower, and the multitude of other factors that determine performance had to be worked out on a trial and error basis with great accuracy and under many widely varied conditions. From the mass of data that was gathered, a sure and precise knowledge of how to design and build the trays for any desired service was developed.

"Maintenance and cleaning problems are greatly reduced by the new trays. They can be made at no extra cost of stainless steel, which is highly resistant to corrosive acids and to caustic products. Their higher capacity is due largely to their simplicity and ability to permit a straight-through vapor-liquid counterflow in the column. Generally, this permits the design of much smaller columns at substantially lower cost."

The performance of the trays has been confirmed for 25 systems, both hydrocarbon and non-hydrocarbon, representing a pressure range from 5 psia to 300 psig. This pressure range represented a vapor density range from 0.04 to 2.8 pounds per cubic foot, vapor-liquid density ratio from 10 to 1000 and vapor-liquid volume flow ratios from 10,000 to 5. Shell says no Turbogrid tray installation has failed to meet design capacity.

Details Soon

EXCLUSIVE!
NEXT MONTH PETROLEUM REFINER WILL CARRY THE FIRST EXCLUSIVE PAPER ON THE TURBOGRID TRAY. LOOK FOR IT.

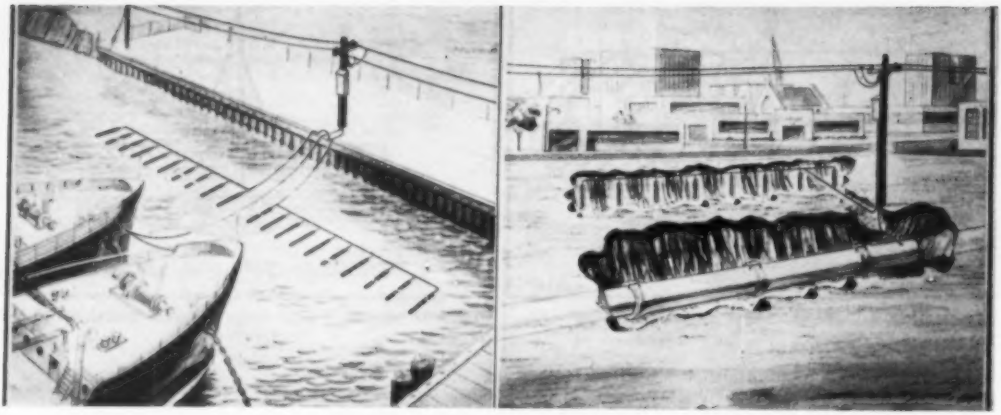


Figure 1a. Typical examples of graphite ground anode cathodic installations.

Cathodic Protection Licks Corrosion

Management: What is your stake in cathodic protection? Here are the answers.

L. C. Workin
National Carbon Company
Division of Union Carbide and Carbon Corporation
Cleveland, Ohio

CATHODIC protection is a positive, controllable and inexpensive method of preventing corrosion. There is real money in reducing these losses caused by corrosion — maintenance, replacement costs, over-design of equipment, and product losses due to downtimes. Refinery management and technical personnel must be keenly aware of the creeping inroads of corrosion, and alert to any feasible solution to the problem.

Corrosion Losses Staggering

The magnitude of corrosion losses in terms of dollars and critical metal wastage can be underscored best by quoting figures. In 1949 it was reported that the annual direct cost of corrosion in the United States was $5.5 billion dollars.[1] Enough steel is converted to non-useful oxides each year to build an entire fleet of battleships.[2] Indirect losses cannot be estimated and are of such a varied and broad nature that even a calculated guess is untrustworthy. They include loss of life and limb, the psychological factors attending unpredictable service interruptions, explosions, oil contamination, in fact an almost inexhaustible list of side effects. There are many examples on record to show that these losses are truly staggering.

A great portion of the total losses must be charged against corrosion of buried or submerged metal structures. Some types of corrosion losses are difficult to control but a cathodic protection system is practical, calculable and precise for this problem.

There undoubtedly are many reasons why the annual cost of corrosion losses in the United States is not known in exact figures. It is difficult to understand, however, why some companies analyze their overhead costs in great detail yet seem to have but a vague idea of the existence of a corrosion cost without even an approximation of its magnitude.[3] Management's concern with corrosion and the economic evaluation of a corrosion control program should be just as complete as with any other problem in the light of its responsibilities to the investors, customers and employes.

What Is Cathodic Protection?

It may be well to state briefly the nature of corrosion of underground and submerged metal structures, and its cause. The corrosion engineer understands the subject but the facts of cathodic protection are not always so well known to management.

Buried or submerged metal structures are, of course, subject to corrosion, the rate of attack being accelerated by such factors as inequalities in the metal itself, soil acidity, degrees of aeration, and the like. In many respects, the action is similar to that which takes place in a galvanic cell or battery. In this reaction, current flows between two poles with a resulting deterioration of one of these. As corrosion proceeds, particularly if accompanied by pitting, the metal structure is weakened or honeycombed to the point of uselessness and costly replacements are required.

To prevent this destruction, cathodic protection can be applied in several ways.

Sacrificial anodes, such as zinc, aluminum or magnesium, are buried in the soil and a metallic connection is made by insulated cable directly to the structure to be protected. In this case, the sacrificial anode takes the punishment while the structure goes relatively untouched. If the sacrificial anode is in a moist environment it forms compounds with the soil and

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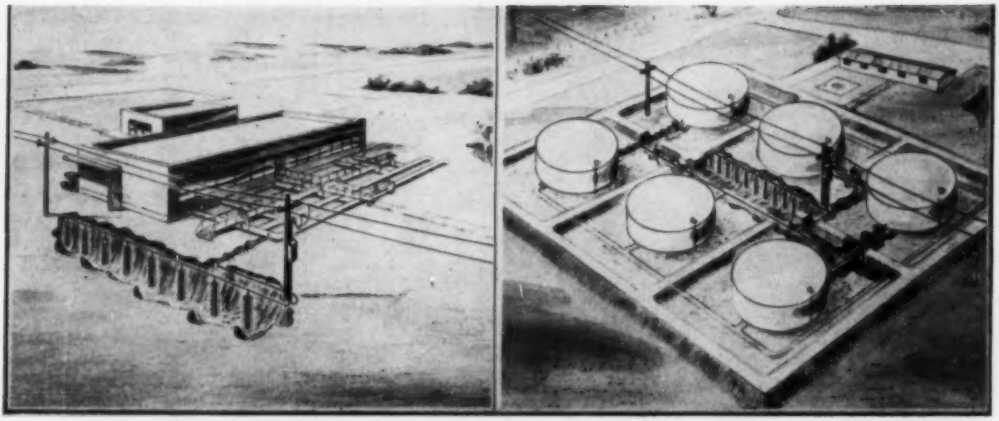

Figure 1b. Typical examples of graphite ground anode cathodic installations.

the moisture and the current flows from the anode to the structure. The amount of potential created by such anodes is inherently limited and control is obtained by varying the size and number of anodes used. Since sacrificial anodes create current by consuming the anode itself, they must, therefore, be replaced at intervals.

When current is to be transmitted to the soil from an external source, carbon, graphite or scrap iron anodes are used. The current is supplied from the positive side of a rectifier, battery or generator; the negative side is connected to the structure to be protected. By the use of a suitable voltage, it is possible even in high-resistance soils to force a maximum current through a given number of anodes. The current passes through the soil which is the electrolyte, and into the negative metal structure to complete the electrical circuit. As long as sufficient current is applied to this type of anode and the anode is in contact with the soil the cathodic protection action is positive and controllable, and corrosion cannot occur. Carbon and graphite function as insoluble anodes, and their use obviates the practice of burying and consuming metal that is so urgently needed as scrap.

Over-design Due to Corrosion Allowances

To return to the discussion of corrosion losses, there appears to be scant analysis of the tons of metal consumed each year because equipment is over-designed to allow for corrosion. The design engineer often specifies metal thicknesses much greater than those required to ensure adequate strength and continued performance. Over-design as corrosion insurance is common in the construction of condensers, buried pipes, storage tanks, loading docks, piers, and other equipment.

The tremendous wastage of metal through over-design and corrosion is of international importance during these times of defense production and metal shortages when every effort is being made to conserve materials. This is a challenge to engineers, scientists and business executives in that even a small improvement, by cathodic protection of underground and submerged metal structures, would result in annual savings of millions of dollars and thousands of tons of critical metal.

As an added bonus, the reduction of pipe wall thickness also provides a larger internal diameter pipe, having approximately 5 percent greater capacity, making possible additional gains over the initial saving of steel. Based on the length of all pipe lines in the country, a 5 percent increase in capacity is equivalent to more than 50,000 miles of pipe.[1]

Product Losses

Product loss resulting from corroded equipment is another large item of both direct and indirect cost. Leakage from a corroded pipe may cause waste of large amounts of gas or petroleum. This, in itself, is a fire hazard that may endanger an entire refinery, in addition to the explosion factor which could result in loss of human life. It is possible also that petroleum may leak into a water reservoir and contaminate an entire municipal supply. An extreme example of product loss is recorded, relating to a 40-mile pipe line so badly corroded that 90 percent of the product was lost through perforations in the pipe.[4]

The cost of shut-downs through corrosion is another large figure. In oil refineries, replacement of corroded tubes in only one unit may cost $800 per hour because of lost production.[1] And the cost of replacement must be added to this.

Maintenance Costs

Other examples of the value of cathodic protection within oil refineries may be summarized:

One of the larger refineries, reporting on the installation of cathodic protection on its pipe line system, states that the cost of maintenance might have increased by 500 percent during an eight year period if corrosion had been allowed to take its course. By systematically expanding the cathodic protection system, an average reduction in cost of 65 to 70 percent has been achieved, at a construction and maintenance cost for cathodic-units installations of 30 to 35 percent.[6]

For open-box-type coolers another refinery has found that cathodic protection has been a paying investment. The pipe coils in one cooler had a service life of approximately 30 months, and the annual maintenance cost was estimated at $6000. After the installation of a cathodic protection system, protection was achieved on approximately 65 percent of the coil-and-box surface area. Cathodic protection was providing a total life of four years as compared with an expected life of 2½ years without protection.[7]

Table 1 shows various cost estimates and savings resulting from the use of cathodic protection on large open-box-type refinery condensers and large diameter Dorr clarifiers:[6]

A corrosion engineering authority

Figure 2. Example of corrosion pitting in pipe section that was not cathodically protected.

Figure 3. Pipe system terminating in valve pit. Workmen are insulating flanges as a step in installing cathodic protection system.

states that a large service organization had a 1948 budget item of around $200,000 for pipe replacements. It was estimated that it cost the company about $150,000 a year to replace lines because of corrosion. A careful study showed that an expenditure of $75,000 on cathodic protection would do a better job than to spend $150,000 for replacements. In addition, the studies showed that an investment of $1 million for cathodic protection on older lines, ahead of the time when they would have to be replaced due to corrosion leakage, could realize an annual return on the investment of about 30 percent.[9]

Cost Of Depreciation

Another corrosion item of major interest to management is the increased annual depreciation charge due to the shortened life of pipe lines and other equipment. In corporation bookkeeping it is valid to consider an annual depreciation charge as a sinking fund deposit which, if invested each year, would accumulate to a sufficient amount during a given estimated life period to replace the structure. For example, consider a pipe line which is estimated to have a life of ten years in some particularly corrosive soil area. In that ten years the sinking fund deposit must accumulate to an amount equal to the replacement cost of the line, less any salvage value, plus the cost of salvage. In many cases the last two amounts are considered to balance each other and the accumulated amount is set to equal the cost of the new line. Should a cathodic protection system be installed that would extend the life of this pipe line to twenty years, the sinking fund deposit would be diminished accordingly and the savings increased in like proportion.[2]

Because of the early recognition of the corrosion problem in pipe line construction and operation there is a great abundance of documentary records to substantiate the facts. The annual direct loss on underground pipe lines alone is estimated to be $600 million,[1] with an additional loss for oil refinery equipment of $50 million. The indirect losses added for pipe lines by another authority brings the figure up to something over $1 billion annually.[2]

Undoubtedly the use of cathodic protection offers extensive opportunity for reducing the enormous losses incident to underground and underwater corrosion, and consequently for real conservation of critical materials. Whether or not an organized and permanent effort is made to control such losses will depend on managements' determination to recognize the problem, learn the facts and then act.

Table 1

Budget Item	Large Condenser	Dorr Clarifier
Replacement cost of equipment, new	$16,000	$125,000
Annual depreciation rate of painted tank, 3 percent	480	3,750
Portion of depreciation due to underwater, 90 percent	432	1,875
Maintenance cost, one year	1,000	4,500
Total annual maintenance costs eliminated by cathodic protection	1,432	6,375
Cost of cathodic protection system	2,750	4,000
Annual power and electrical costs	370	1,400
Savings first year	−1,318	+2,375
Savings second year	−256	+2,600
Savings third year	+806	+2,600
Savings each additional year	+1,062	+2,600

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Aerial view of 4500-gpm separator at Sohio's Toledo refinery.

The Water Pollution Problem—Get Ready to Tackle It!

Here are the three pollution "whats":

- **What it is**
- **What you can do about it**
- **What the law requires of you**

Melvin Nord
Consulting Engineer, Detroit

REFINERY MANAGEMENT must reach for their check book— and there won't be any profits coming in to match their costs. The problem is water pollution, and the public has forcefully stated that it wants the problem solved. Here is the full story on what water pollution can mean to you, and the steps you must take to preserve your good public relations.

The problem of water pollution is not a new one, but its importance has been greatly magnified by the unprecedented growth of the industrial plant of the United States, and by population growth and movements. Within the past decade, the problem has become acute, and drastic regulatory means have been invoked by governmental and other public groups. Sudden pressures have, in many cases, been brought to bear against industry in an attempt to force an overnight solution to problems which have been accumulating over a long period of time. This has in many individual cases worked undue hardship, often accompanied by a resentful attitude on the part of industry. While this is not the usual case, it occurs frequently enough to warrant considerable attention. Where these difficulties exist, they can usually be traced to an inadequate appreciation of the nature of pollution, of its causes and effects, and of the means of alleviating it. The present paper endeavors to call to the attention of the oil industry some of the basic factors involved.

What Is Pollution?

Strangely enough, one of the basic sources of confusion and misunderstanding is the word "pollution" itself. This is indeed a slippery word—one which has an entirely different connotation to the various types of people involved. When a manufacturer is charged by a state or local administrative board with polluting a stream, his reaction almost invariably is one of shocked amazement. He cannot believe his ears or his eyes. Surely someone must be joking, or else that "bureaucratic" board is crazy—or are they looking for a "handout"? To him "pollution" is a dirty word. *He* never dumps oil or sludge into the stream. Nothing leaves his plant but good old aqua pura! How they can claim he is polluting the stream is beyond him. It's an insult and an outrage! When he is charged with increasing the phenol content of the stream, he is positive that someone is crazy or that a competitor has "gotten to" the party making the charges. Why, he's never even had any phenol on the premises in all the time he's been operating.

To the layman, "water pollution" means something else again. When he hears this expression, he thinks his drinking water is being poisoned by some secret "chemicals" or "acids" like "caustic soda," or that he is about to contract an acute case of tuberculosis, with complications in the nature of amoebic dysentery and other diseases too horrible to think of. Who do they think they are—coming into our "residential" community with their dirty factories and "sullying our fair streams"? They should be made to pay (preferably through the nose). If these companies can't behave, let them "pack up" and "go elsewhere" (presumably to pollute somebody else's stream).

Fortunately, the attitude of the administrative boards (particularly at the state level) is much more sensible than either of these "views". These boards are normally administered on the working level by technically trained personnel who are in a position to understand the legitimate problems of both industry and the public

and to apply whatever scientific information is available to water pollution problems. So long as these boards are not in the hands of politicians out to "make a good record," they are refreshingly cooperative in their attitude. They sincerely desire to "impel." rather than "compel" compliance with the statutes and regulations under which they operate. To them, the word "pollution" is a *relative* term, rather than an *absolute* one. They realize that "pure water" exists only as a mental concept, that all water contains some "contaminants" of one sort or another, and that it is normally a question of degree whether or not water shall be said to be "polluted." They generally understand that a specification such as "no oil shall be discharged into a stream" is meaningless, and that tolerances must be worked out. Up to the present time, there has been no standardization among states and municipal agencies as to the allowable concentration of each contaminant, but there has been a start in this direction in many places. These tolerances should not be applied indiscriminately; they require the exercise of judgment, as will be shown later in this paper.

There remains also to be considered the viewpoint of the legal profession as to the meaning of the word "pollution." It has been the experience of the author (as a member of both the engineering and legal professions) that lawyers are often unaware of the fact that pollution (or anything else, for that matter) is not a black-and-white proposition. They have considerable difficulty in understanding that "some" oil must be expected to be discharged into the stream by virtually every oil refinery. The best way to clarify this point in their minds is to point out to them that the air they exhale "contaminates" the atmosphere with carbon dioxide and other "impurities," and that this "willful and wanton pollution" of the air could readily be terminated by the simple expedient of their "ceasing, desisting, and refraining from the practice of contaminating said atmosphere—to wit, cease breathing."

Contaminants—Effects and Tolerances

Table 1 summarizes the principal effects of the common contaminants in water.[1]

In general, it may be stated that industrial stream pollution does not cause disease. It is primarily an economic problem, rather than a public health problem. However, where the pollution causes a widely fluctuating chlorine demand in municipal water purification plants, it may indirectly contribute to disease through incomplete chlorination of the water. Normally, however, the only effect of industrial pollution on municipal water treatment plants is to increase the cost of their operation.[2]

Table 1—Effect of Contaminants in Water

Undissolved Materials:	
Bacteria	Certain types are beneficial, helping to purify the stream; others (not usually present in industrial wastes) are pathogenic.
Suspended Solids	Turbidity, deposition on bed and banks of stream.
Oil	Scum on surface, odor, damage to boats and banks; may be a fire hazard.
Dissolved Materials:	
Salts	May cause hardness, alkalinity, taste, corrosiveness, boiler scale, foaming in boilers.
Acids	Corrosive to metals, toxic, reduce bacteria content of the stream.
Metals	Taste, color, corrosiveness, hardness, toxicity.
Oxygen	Corrosive to metals, necessary for fish life and for stream self-purification; not regarded as a contaminant except for boiler feedwater.
Organic Compounds	Reduced oxygen content of the stream due to biochemical oxidation reactions in the stream; may cause putrefaction odors and destruction of fish and plant life; increased chlorine demand in municipal water purification plants; phenolic compounds cause taste in water which is subsequently chlorinated.

The effect of oil is worthy of special attention in this article. Because it is not miscible with water and floats at the surface, oil is readily detectable visually in minute amounts; it also is more harmful for this reason. It may collect in rushes or on the banks of the stream where it is unsightly, emits odors, and is generally regarded by fire departments as at least a potential fire hazard. One of the sad facts about oil discharged into a stream is that it may remain on the banks as a constant reminder of past "misdeeds." This is especially true if the oil has been discharged into a lake, into tidal bodies of water, or into brooks which "dry up" during part of the year.

Sampling methods for oil in plant effluents and in streams are rather inadequate, because of the difficulty in obtaining a representative sample. Unless the samples are obtained over a period of time and over a cross-section of the flow, they are likely to be magnificently inaccurate. Gross errors of this type often appear when one tries to make a material balance on the increase in oil concentration of the stream as it passes the plant, checking it against the concentration of oil in the water discharged to the stream. The usual method of analysis of oil (as ether-solubles) is also not very satisfactory, since it doesn't distinguish between dissolved and undissolved oil. Since the tolerances for oil (as ether-solubles) in effluents are normally between 15 and 30 parts per million, it is quite possible for them to be exceeded even though no immiscible oil is present. When "oil" in an effluent is discharged into a stream it may become further diluted if it is already dissolved in the water, but it may float to the top if the oil was originally suspended rather than dissolved. The latter phenomenon is likely to occur if the effluent is cloudy. When the oil floats to the top of a body of water, it spreads out in a very thin film, so that it evaporates quite readily even if it has a low vapor pressure.

The most important characteristic of streams, insofar as the chemical and petrochemical industries are concerned, is the oxygen content of the stream. If this is completely exhausted by biochemical oxidation of organic wastes, green plant and fish life in the stream are destroyed. In addition, the decomposition of the organic matter then occurs by means of anaerobic organisms, which produce unoxidized low-molecular weight compounds such as hydrogen sulfide and ammonia. The attendant odors of putrefaction are often very disagreeable. On the other hand, if the stream contains dissolved oxygen, the decomposition of organic matter occurs by aerobic organisms. The products formed in this way are oxidized odorless gases and solids. Thus, the presence of dissolved oxygen in a body of water permits it to undergo a process of self-purification.

Important Polluting Criterion

An important criterion of the polluting effect of chemicals on water is the biochemical oxygen demand (b.o.d.), which measures the reduction in dissolved oxygen over a fixed period of time by biochemical action. In the b.o.d. test, a mixture of the sample and pure water is placed in an incubator at 20° C. for five days, and the decrease in dissolved oxygen content of the mixture is measured. The biochemical reaction is very slow; it is normally only about 70 percent complete at the end of five days, when the test is stopped. B.o.d. tolerances for effluents are ordinarily between 25 and 100 ppm., while b.o.d. tolerances for the streams themselves vary between 0.5 and 30 ppm., depending largely on the principal use of the stream.

The b.o.d. test is interfered with if toxic substances are present which destroy the bacteria necessary for the biochemical reaction. In this case, one can measure only the chemical oxygen demand (c.o.d.) by refluxing the water for an hour or two in the presence of

an oxidizing substance such as sodium bichromate. Unfortunately, there is no satisfactory correlation between b.o.d. and c.o.d. If there are toxic substances present, they constitute a serious pollution condition in themselves. If their presence is not suspected, the b.o.d. test may give a deceivingly low result. (Let us hope that no one thinks the moral of this story is that it's a good idea to add toxic materials to a plant effluent in order to reduce the apparent b.o.d.!)

The question also arises whether a high b.o.d. in a plant effluent is necessarily intolerable. While a high b.o.d. in a plant effluent is always undesirable and is always regarded as pollution, the capacity of the stream for self-purification should also be considered. It should be noted that as the dissolved oxygen content of a stream is reduced through biochemical action, the rate of diffusion of oxygen into the water from the air increases, because of the increased concentration gradient. A plot of the course of the biochemical reaction in a stream therefore will resemble the upper curve in Figure 1.

It will be observed that a minimum concentration of dissolved oxygen occurs at a point downstream of the point of discharge of the plant effluent, generally a considerable number of miles downstream. The maximum depression of the oxygen content of the stream will not, normally, be as great as the b.o.d. test would indicate. However, it is possible for it to be even greater, since the biochemical reaction is incomplete in the b.o.d. test.

If the water is warm, so that its maximum possible dissolved oxygen content at saturation is relatively low, the diffusional driving force will be low, so that reaeration will be slow. In addition, the stream itself upstream of the plant will be relatively low in dissolved oxygen to begin with, under these circumstances. This is the worst possible condition.

Stream Turbulence

Another factor influencing the rate of absorption of oxygen by the stream from the air is the amount of turbulence of the stream. A rapidly flowing stream, particularly a shallow stream or a brook, will have a relatively high rate of absorption of oxygen from the air. On the other hand, a relatively stagnant body of water represents a very undesirable situation. Other factors which affect the significance of the b.o.d. test are 1) the use to which the water is put, and 2) the distance or length of time, before the stream empties into a larger body of water such as a large lake, a bay, or the ocean. If the stream discharges in a short time into a much larger body of water, there is less reason to be concerned with the b.o.d., for there will be insufficient time for the biochemical reaction to occur in the stream before it becomes greatly diluted in the larger body of water.

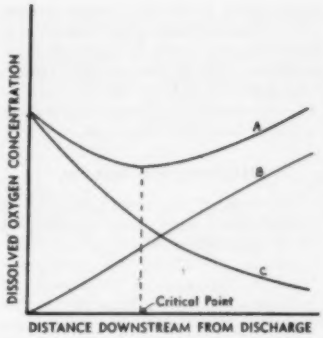


Figure 1. Oxygen balance of a stream. A–Dissolved oxygen in stream; B–Diffusion of oxygen into stream from air; C–Oxygen consumption curve.

In addition to the specification of oil content and b.o.d., other standards commonly employed are the following: pH: generally between 5.5 and 8.5; maximum suspended solids: none to 100 ppm (usually "none"); maximum chlorides and other dissolved solids: 750-2500 ppm; minimum dissolved oxygen: 1-5 ppm; maximum phenolic compounds: 5-30 parts per billion. In addition, there are often vague specifications on color, odor, and turbidity of effluents, such as "slight," "not noticeable," "not objectionable," "practically free," or "free."

The reason for the extremely low tolerance on phenol content is that if the water is subsequently chlorinated in a municipal water purification plant, chlorophenols will be formed, and these impart an objectionable taste to the water. It should be ovbious therefore, that if the water is actually not going to be chlorinated, the phenol specification will be irrelevant. In such a case, phenolic compounds are no more undesirable than any other organic compounds (certainly not a thousand times as undesirable) and their presence may be taken account of sufficiently by the b.o.d. test.

The extremely low values of the tolerances must be kept in mind when one is tempted to deny that "any" contaminants are being discharged into a body of water. Plant operators normally figure yields to 1 percent. The tolerances for contaminants in plant effluents, however, are of the order of magnitude of 0.001 percent (10 ppm) and down to 0.0000005 percent (5 ppb). This is indeed plant operation on a "micro" scale. By way of illustration, assume an effluent of 100 gpm containing 5 ppb of phenolic compounds. This amounts to only about 2 *grams per day* of phenolic compounds! It follows that any plant dealing with organic materials having any measurable phenol content is likely to have a "phenol" problem in its waste if a phenol tolerance is in effect in the locality.

Systematic Analysis of Pollution Problems

While it is true that each individual water pollution problem requires individual analysis and treatment, nevertheless there are some techniques which are common to nearly all pollution problems. If a systematic method of analyzing the problem is used, a great deal of time and money can often be saved in the solution of the problem. Too often the approach to a water-pollution problem is from the wrong end, i.e., with the idea of finding the proper treatment method for removing certain wastes from the water. This should be one of the last steps in the solution of the problem, rather than the first.

Normally the first step in the solution of any problem is a "fact-finding expedition." Before the problem can be solved, it is necessary to know just what the problem is. Thus, in attacking a water pollution problem, one should make a strong effort to determine what the contaminants are, how much is present in the effluent, where it comes from, and where it goes.

Sampling and metering of the various effluent streams (before they are joined into a single stream) are normally the first order of business. Since many of the streams vary in composition and flow rate from time to time, this may not be as simple as it sounds at first. If there are immiscible substances present, such as oil, the difficulties may be multiplied. Continuous automatic sampling devices may be used if the problem warrants; otherwise hand sampling devices may be used. Neither method is infallible nor is any better than the judgment of the person doing the sampling or installing the sampling device. In many cases, the compilation of such data is of prime importance. This is especially the case in large, complicated plants. However, the accumulation of such data is time-consuming and ex-

pensive, and it should not be made a fetish.

While quantitative information as to flow rates is generally important in determining the design size for treatment facilities, qualitative information as to composition is satisfactory for some streams. Thus it is just as important to know that certain streams are "not contaminated" as it is to know how much oil is carried in one of the process streams. The effluents should be classified qualitatively according to whether they are process water, storm-water run-off, or uncontaminated cooling water.

Chemical analysis of process water is normally required, but as to the other two kinds, it is primarily necessary only to know whether they are "contaminated" or "uncontaminated." Cooling water may be contaminated by heat-exchanger leaks, or by the accumulation of sediments in the water side of heat exchangers, especially at return bends or headers. As to storm water run-off, it is very important to keep as much of this water as possible from becoming contaminated. This requires separate sewers for storm water, so arranged as to divert as much of this water as possible from running across the surface of oily ground. This is a housekeeping problem of considerable importance.

Segregation Sometimes Simplest

Segregation of uncontaminated from contaminated waters is often the simplest and most effective way of reducing the magnitude of a water pollution problem. In the first place, it often reduces the size of the treatment facilities by a large factor; and in the second place, it reduces the total amount of contaminants which leave the treating plant and are discharged to the stream. It should be kept in mind that treatment equipment will in general operate more effectively on high-concentration wastes than on very dilute wastes. In oil skimming operations, for example, the concentration of oil in the entering stream is almost irrelevant; it is the amount of water to be treated which primarily fixes the design of the skimmer. If one permits uncontaminated water to be mixed with oily water and then to go through an oil skimmer, the result will be a much larger amount of waste effluent and a somewhat higher concentration of oil in the effluent. Thus, the simple expedient of by-passing uncontaminated water around the treatment plant and discharging it directly to the stream will sometimes minimize what at first appears to be a very serious pollution problem. This is one of the reasons why it is wrong to go about the solution of a pollution problem by starting with the treatment facilities.

Minimize the Amount

Segregating uncontaminated from contaminated waters may be regarded as an illustration of one of the basic principles in solving pollution problems, viz., *minimizing the amount of contaminated water*. This can be accomplished not only by segregating cooling water and uncontaminated storm water from process water, but also by minimizing the amount of process water used. Because "water is cheap" plant operators rarely worry about using two or three times the amount really needed in the process. While water may be cheap, purifying contaminated water is not. By proper education and policing policies, it is sometimes possible to cut the process water requirements in half. In some cases, waste process water which is only slightly contaminated can be re-used or can be used in another part of the process.

In connection with water re-use, one of the problems which should be considered is the desirability of re-using all or most of the treated waste, instead of discharging it into a stream. While treated plant effluents may not be useful for all plant purposes, they may be perfectly satisfactory for some plant purposes. After you have spent a lot of money in treating waste water, it's a pity to discharge it into a stream. It may be cheaper to re-use it in the plant. Also, when the pollution problem is very difficult, it may be that the only solution which is certain to provide a cure is to refrain from discharging *any water at all* to the stream, and to use a recycling system instead. Particularly is this true where the process water is highly contaminated and the tolerance allowed is very low.

Check the Source

The second basic principle in the solution of pollution problems is to minimize the degree of contamination of the water *at the source*. Up to a certain point, it is easier to prevent contaminants from getting into waste water than it is to get them out afterwards. In some cases, good housekeeping, such as cutting down leaks and spillages, will go a long way in this respect. In other cases, it is necessary to study the process itself. Process changes might be adopted which would cut down the amount of contaminants entering the waste water, or might even change the type of contaminants. Where the waste is phenolic this is particularly important in view of the low tolerances often placed on phenol in plant effluents. Since it is the process which produces the waste, it is only logical to try to cut down the magnitude of the problem at this point. In some cases, a slight alteration of the process will permit the use of closed heating coils instead of open steam, or a shell-and-tube condenser instead of a barometric condenser; these convert process water streams into uncontaminated water streams. In sulfite pulp mills, it is estimated that the cost of proper b.o.d. treatment of the waste would equal that of the mill itself. This is one place where re-examination of the process itself requires consideration.

In the case of oil refineries, it pays to follow the principles outlined above. It pays in the form of reduced water treating costs, and it pays in the form of reduced oil losses. A good housekeeping system, involving the prevention of leaks and spillages, segregation of water streams, and careful analysis of the process to reduce wastes, should more than pay for itself.

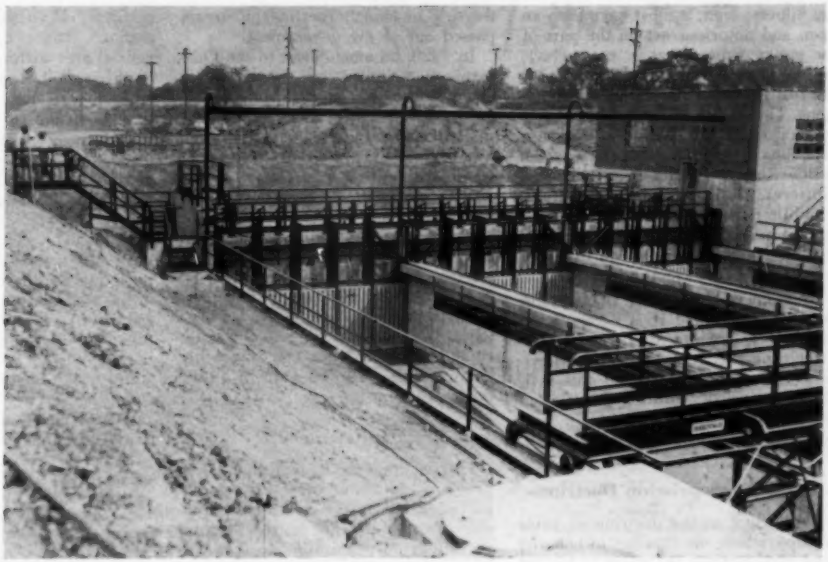
Legal Aspects of Water Pollution

Legal problems involved in water pollution problems are comparable in complexity with the technological problems. Some of the basic legal problems will be outlined with the idea that an "ounce of prevention is worth a pound of cure." More detailed treatment of the legal problems involved can be found in other articles of the author.[6, 7, 8]

According to the common law, which is the law most often dealt with in court cases, liability for pollution may be based on either the *nuisance doctrine* or on *riparian rights*.

A nuisance may be defined as an unreasonable interference with the use of one's land by another in the use of *his* land. The crux of nuisance problems involves the meaning of the word "unreasonable." This word is too broad to permit of precise explanation, and it can only be understood in relation to nuisance cases which have already been decided by courts. A few principles have emerged:

1) There need be no negligence, nor any intent to harm another, in order for an act to constitute a nuisance. It is the wrong done which matters, and not the reason why the wrong was committed. Therefore, you cannot show that no nuisance exists merely by proving that you are doing everything which it is at present possible to do



Sohio's new waste water separator at Lima, Ohio. It's a construction view.

to clear up the pollution problem. The law feels that there is always one more thing you can do, i.e., stop operating.

2) It's no excuse that others are doing the same thing. This defense is useless in nuisance cases, as it is elsewhere in the law. The argument that you are not polluting the water, since it is already polluted is no good if you are adding substantial amounts of contaminants yourself. If this were not so, there would be no way at all to overcome serious pollution conditions which are contributed to in small amounts by a large number of plants.

3) The act need not be a continuing one in order to constitute a nuisance. However, if it was merely an isolated instance which will not recur, damages will be granted but an injunction will be refused. The court will not enjoin the operation of a plant unless it is continually causing substantial injury to another.

What Kind of Injury

4) This brings up the question of what kind of injury must be committed in order to constitute a nuisance. The answer is that it need not be an injury to health. It can cause physical or mental discomfort, or interfere in some other way with the use of someone else's property.

If the nuisance affects the public generally, which is often the case in stream pollution problems, it is said to be a public nuisance. This is subject to abatement by the public, and is a misdemeanor.

A more common basis for liability for stream pollution, where private individuals are involved, is interference with riparian rights. One who owns (or occupies) land adjacent to a waterway has certain rights to the use of the water which must not be interfered with by another "riparian owner." According to the old view, which is fortunately obsolete in most jurisdictions in the United States, every riparian owner was entitled to have the water come to him in its "natural state," undiminished in quantity and uncontaminated. What this meant, in effect, was that no one could make much use of the stream if there was a riparian owner downstream, and the lowest riparian owner had practically unlimited rights to the use of the water.

In most states, with the exception of certain western states where water is scarce, the "reasonable user doctrine" now is applied. According to this doctrine, each owner is entitled to make a reasonable use of the water. He can, for example, add an amount of contaminants to the water which does not unreasonably interfere with the use of the water by lower riparian owners. Thus, if no one downstream has any use for the water, an upstream owner can do almost anything he pleases to it (aside from liability for public nuisance). However, if he builds a plant adjacent to a stream with this in mind, he may later on find that someone else wants to use the stream and cannot do it. The plant will then be engaging in an "unreasonable" use of the water, and an injunction will normally be granted to stop this. Thus, while the "reasonable user" doctrine is fairer and more practical than the older "natural rights" doctrine, it is by no means perfect.

The right to pollute waters may be purchased from a riparian owner, but it is binding only on him and successors to the title of his land. It does not extend to other riparian owners who have not made similar agreements. The fact that some riparian owners have made such agreements does not prevent other riparian owners from insisting on their rights to an uncontaminated stream. Furthermore, if the pollution constitutes a menace to health, or a public nuisance, the agreement is against public policy and cannot be enforced.

How by Prescription

The right to pollute a stream can also be obtained by "prescription," as well as by purchase. This occurs only when each of the following requirements have been met: the pollution must have been injurious to the lower riparian owner, it must have been adverse (that is, without the consent of the lower owner), it must have been under a claim of right on the part of

the upper owner, it must have been an open and notorious act on the part of the upper owner (that is, not secret), and it must have been continued for the full period of the statute of limitations. The statute of limitations begins to run when the pollution becomes injurious to the plaintiff in states which follow the reasonable user doctrine. However, if the pollution constitutes a public nuisance, a prescriptive right cannot arise. In a few states, it is held that the right to pollute can never be acquired by prescription.

In many of the western states, water is very scarce, and it is necessary to obtain very definite rules which at the same time permit the broadest utilization of streams. Because of this fact, the doctrine of prior appropriation has been adopted as the rule in most of the arid states.

Prior Appropriation Doctrine

According to the doctrine of prior appropriation, the riparian owner who first appropriates the water to his use obtains the right to prevent other riparian owners from using the water in such a way as to interfere with his prior appropriation.[9] In other words, the man who gets there first, gets the water. This doctrine differs radically from the doctrines of natural rights and reasonable user, in that it provides not for equal rights but for paramount right in the earlier user. In the former, prior appropriation has no effect, except where a prescriptive right arises. In the doctrine of prior appropriation, a right similar in scope to a prescriptive right arises immediately upon appropriating water. It is more nearly an absolute right than is obtainable in the reasonable user doctrine.

The advantages of the prior appropriation doctrine are its certainty and the broad utilization of water permitted by it. However, it is not always easy to know exactly what quality and quantity of water has been appropriated.

The doctrine of prior appropriation has been adopted in Montana, Idaho, Wyoming, Nevada, Utah, Colorado, Arizona, and New Mexico. States which have adopted a modified version of the doctrine of prior appropriation are North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Washington, Oregon and California. The usual modification in these states provides that prior appropriation is significant only if it occurred before the title to land bordering the stream passed out of the government.[10]

In 1928, an amendment to the California constitution was made, which changed the law in that state as regards water rights. According to the present law in California, all riparian owners and prior appropriators of water are entitled to such use of the water "as shall be reasonably required for the beneficial use to be served." If any surplus water above these needs is present at any time in the stream, it may be captured by anyone without liability.[11] This doctrine is said to result in the greatest possible beneficial use of the water resources of the state. On the other hand, it is the most indefinite of all the doctrines.

Injunctions

One of the most important legal problems in connection with stream pollution has to do with the circumstances under which a court will grant an injunction prohibiting further pollution. Since this may mean closing down a plant, it is obvious that it is a very critical point in the law. In the first place, it must be understood that the ordinary remedy for a nuisance is money damages. However, where the pollution condition is serious and continuing, the "extraordinary" remedy of an injunction may be granted in the discretion of an equity court. In order to be entitled to "equitable relief," the complainant must have the "equities," and not merely the law, on his side.

Thus, if the complainant has stood by idly while the plant was being built, knowing full well that a pollution condition would result, and has never complained until it was too late to do anything about it, he will not be granted an injunction. Or if he is guilty of any other inequitable conduct in regard to the transaction, he will not be granted an injunction, but will be limited to his "ordinary" remedy of money damages.

This brings up the question whether the party doing the polluting can make out a strong "equitable" case for himself, so as to prevent the issuance of an injunction. He may show that the business is of great value to himself and to the community, and that it would be a greater hardship on him if the injunction were granted than the hardship complained of by the complainant.

There is a split of authority on this point, slightly more than half the jurisdictions holding that they will not consider the "balancing of hardships" in pollution cases. A study of the rule in most of the jurisdictions is summarized in another paper of the author.[6] However, even where the courts are willing to "balance the hardships," it is still a matter of discretion with the court, and an extremely strong case must be made out in order to prevent the issuance of the injunction. In other words, while you can always argue for the "balance of hardships" doctrine to be applied, you can never be certain in advance that it will be. The conclusion is that the only safe course is to eliminate the pollution condition.

In addition to the common law remedies for water pollution, statutory remedies are now available. These do not abolish the common law on the subject, but merely supplement and strengthen it. A survey of stream pollution statutes in the United States and in Canada indicates that pracically all jurisdictions have anti-pollution statutes with "teeth" in them. The statutes vary considerably. Most statutes are administered by state health agencies. The statutes do not generally specify definite types of waste which must be treated, nor do they normally require treatment of all wastes before discharge into streams. Most statutes require presentation to the board for approval of plans for waste water treatment. Penalties imposed by the statutes are generally fines and imprisonment. The board can also apply to a court for an injunction. In some parts of the country, interstate compacts have been made between several states for a single watershed.

A federal stream pollution statute was passed in 1948 and is administered by the Public Health Service. It does not directly assess liability for pollution, but instead provides monetary aid for state enforcement agencies, and loans to industries and municipalities for the construction of pollution control plants.[4] The statute is based on the power of Congress to regulate interstate commerce. This is an extremely strong power, which may be further exercised in the future.

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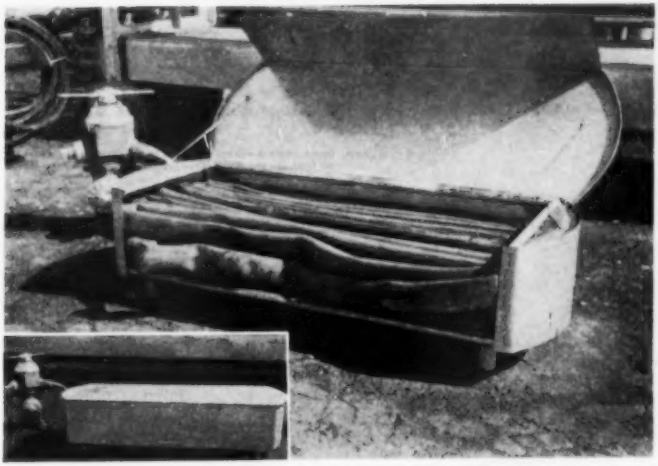
MAINTENANCE / OPERATION



Fire Hose Is Stored in Unusual Housing

The two most important considerations in designing a container or rack for fire hose are 1) ease of removal of the hose, and 2) provision of maximum protection to the hose against rot, mildew and weather. The unusual design shown in the accompanying photograph meets both of these requirements exceptionally well. The oblong-shaped box is seven feet long by two feet wide and was built in the refiner's shop from galvanized iron. It has a capacity of about 150 feet of hose.

The container is supported above the ground by short pieces of two-inch pipe. This insures that air can circulate freely up through the grate on which the hose is supported. Thus the hose can be kept dry at all times and damage from moisture and mildew is prevented. The cover on the box makes two contributions: it shields the hose from the harmful effects of direct sunlight, and dresses up the appearance of the container.

Container Is Practical

The hose is easily accessible. The suction end is kept attached to the fire plug. The fact that the hose is laid out in long rectangular lengths, rather than coiled, guarantees speedy removal in an emergency. The entire assembly costs about $50.00, including labor. The unfortunate and somewhat macabre resemblance of the container to a coffin need not detract from its usefulness!

Maintenance and Operation Ideas Are Worth Money

Send Your HOW TO DO IT suggestions with photos or sketches to Editor, Petroleum Refiner, Box 2608, Houston, Texas.

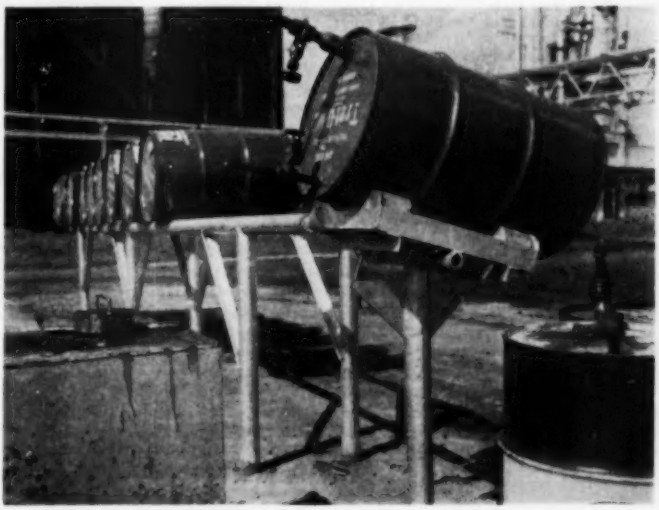
Drum Draining Rack

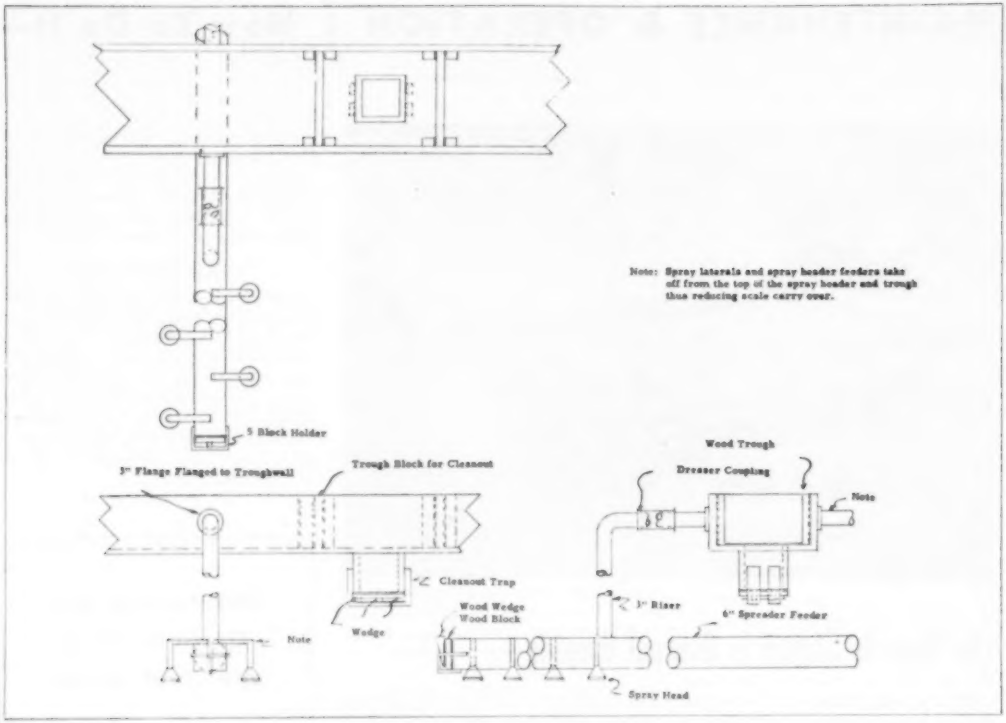
There are two annoying problems associated with handling lube or solvent oil drums.

- They're too heavy to handle—a full drum will weigh 450 pounds.
- The last two or three gallons are likely to be left in the drum.

One refinery has solved both of these problems with the neat, inexpensive, shop-fabricated rig shown in the illustration. The rack is four feet high by 30 feet long. It was made by welding the proper lengths of salvaged 3-inch pipe and 2-inch angle iron. A chain hoist (not shown in picture) lifts the loaded drums on to the rack. They can be easily rolled down the pipe to the saddle on the end. The saddle can be rotated through an angle of about 30° so that the last drop can be drained off. The turning rod for the saddle is made very economically by welding the saddle to a length of 2½-inch pipe which revolves in a slot made from 3-inch pipe.

The whole rig can be made from scrap with about 15 man-hours of labor.





Sprayheaders—Keep Them Clean

THE sprayheaders of cooling towers are highly susceptible to clogging by scale. The design in the drawing above is one way for the quick and easy removal of this scale.

The individual sprayhead laterals come off the top of the sprayheader. Sprayheader feed lines are also brought off the trough at the top. This is done to insure that the entire system channels through the clean out boxes which are spaced in the system at convenient intervals. An additional improvement is realized by placing removable wooden blocks at the ends of each of the spreaders. Then, when it is time to clean the system, the blocks can be removed and the spreaders flushed. Making the blocks of redwood insures maximum resistance to deterioration. The thirty-bay tower in which this system was installed has clean-out boxes and trough blocks at every ten bays.

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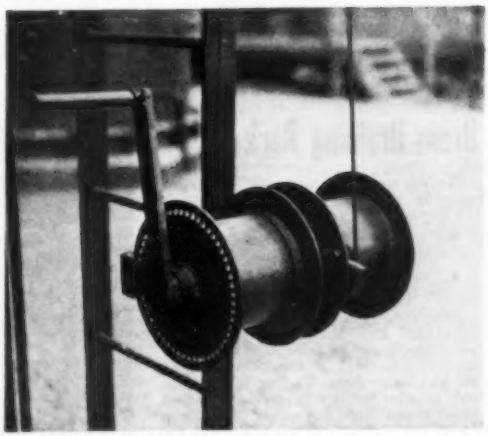
MAINTENANCE / OPERATION

Here's One Way to Control Damper Openings

EXACT control of damper opening is accomplished at one refinery with a hand-operated winch, designed so that any degree of closure can be obtained. The winch pictured, which accommodates two stacks, has a double drum mounted on a tubular shaft which provides a means for attachment to any vertical stanchion near the equipment. The drums are rotated by a shaft inside the tubular member to which a crank has been attached. The drum flange at the crank end is drilled with closely spaced holes to accommodate the use of a spring-loaded, locking pin.



Adjustments are made by disengaging the pin with one hand while rotating the drum with the other hand for the desired damper setting. Releasing the pin automatically sets it into one of the holes for a permanent setting.

"Sprayheaders—Keep Them Clean" is a prize winning "Operation Kinks" from the Permian Basin Regional Meeting of NGAA, Odessa, Texas, February 29, 1952.

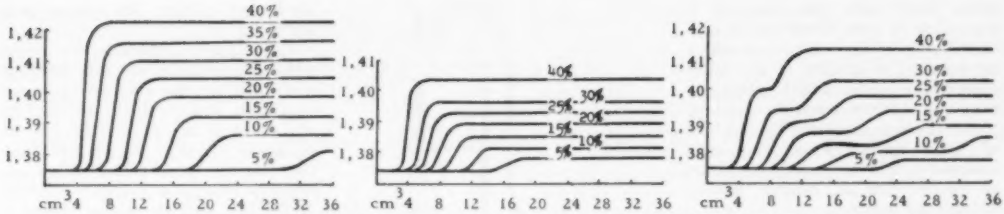


Figure 1. Adsorption Curves of Benzole (left), Cyclohexene (middle), and Benzole-Cyclohexene (right) with Silica Gel. Solvent: Hexane.

Selective Absorption of Hydrocarbons

Part II. Procedure is described for determining the hydrocarbon analysis of gasoline.

G. Spengler and K. Krenkler
Translated by Edwin J. Barth,
Petroleum Technologist

GREAT INTEREST has been recently focused on the separation and purification of aromatic hydrocarbons by adsorption techniques. Parallel with these developments in this country, there has been considerable activity in this field in Germany. A previous article appearing in the August issue, page 231, reported laboratory data on the adsorption of a large group of hydrocarbons on numerous adsorbents. This article now presents a procedure for determining the hydrocarbon analysis of gasoline. This article originally appeared in "Erdol und Kohle," III, July, 1950.

IN CONTINUATION of our investigations on selective adsorption of hydrocarbons,[1] part of which was reported as Part I, in "Erdoel u. Kohle" 3, 120 (1950),* our first problem was to develop a procedure for analyzing gasoline hydrocarbons, a method for separating mixtures of such hydrocarbons into its several components.

The contacting method, used in our work described in Part I, is of no value since that procedure merely exemplifies a displacement of concentration, and indicates very little concerning the nature and quantities of individual components. A method was needed which would divide a mixture according to specific adsorption-affinities of its components. The method of Tswett wherein an adsorption column is employed is suited for this purpose. In this procedure a solution of the mixture (or the mixture itself) is allowed to flow through a column filled with the adsorbent; an exchange mechanism between adsorption and elution takes place, and continues until the total adsorbent is loaded or saturated with the component having the greatest adsorption-affinity. For instance, when the column is charged with a mixture of benzole and cyclohexene (in n-hexane), three components are initially adsorbed. Next, the n-hexane is the first component to be quantitatively eluted by continued or incoming flow of the solution; this is followed by cyclohexene. Pure n-hexane appears first, followed by a n-hexane-cyclohexene mixture; after exhaustive elution of the cyclohexene by benzole, which has remained as the single component still adsorbed, it is observed that the column will now begin to deliver material similar to the charge to the column—namely, hexane-cyclohexene-benzole.

The procedure is now repeated, obtaining the refractive-index on each cubic centimeter of the liquid from the column; the result is plotted, as in Figure 1, showing a characteristic identification curve. The curves are plotted on the column output based on the cubic centimeters charged to the column.

The usually employed laboratory apparati were not exactly suited for this purpose; an apparatus quite adapted to our purpose is shown in Figure 2.

The adsorption columns used in this work were glass tubes 30x1.5 cm., fitted at the lower end with a perforated stopper containing a small stop cock tube; the end of the latter is fitted into an adapter type glass tube, drawn out to a fine point, and open to the atmosphere.

A thin layer of cotton is placed above the perforated outlet stopper at the bottom of the column. The column is next filled with 25 gm. of high porosity silica gel, or 12.5 gm. of activated charcoal. A layer of cotton is placed on top of the adsorbent to prevent disturbance of the latter by the entering charge of liquid. The top of the column is equipped with a small dropping-funnel, connected by tubing to an air reservoir. Upon allowing water to enter the reservoir flask, a slight and controlled pressure can be maintained on the charge liquid and on the column. It is not possible to force the liquid charge through the column without pressure. An optimum rate of flow is about 20 drops per minute. The liquid coming out of the column is measured in a calibrated receiver; refractive indices are determined on the cuts. Normal hexane is a better solvent than the acid-treated benzene previously used. Ordinary pure silica gel and activated carbon were first reactivated by a procedure we had developed; the powders were tested occasionally for stability or permanency.

Actual benzene analyses were used in first testing various synthetic mixtures—for instance, mixtures in hexane containing from 5-50 percent benzole; the purpose being to determine possibilities and general limits of the tentative procedure.

Figure 1 shows the clearly defined

* English translation published in Petroleum Refiner, July, 1952.

curves which have been obtained. It is possible to note differences in concentration to within one percent, where the accuracy is greatest in the lower concentrations. Accurate interpretations are obtained when the gradient of the curve is converted to and read off on a vertical scale. This scale indicates in this case a definite amount of hexane free of benzole coming through the column.

In comparative experiments with hexane solutions of benzole, toluol and xylol, similarly shaped curves were obtained for all three aromatics, using silica gel. However, in the case of activated charcoal this was not the case, since the adsorption was in the ratio of benzole 1 to 1.2 for toluol, and 1.4 for xylol. This corresponds to our previous observations where it was found that the benzole homologues are selectively adsorbed on active charcoal but not on silica gel. Total aromatics content is best determined using silica gel. With active carbon the differences in adsorption-affinities of the benzole homologues are too small to furnish typical or distinctive curves, within range of total aromatics.

An aromatic mixture is usually indicated by quite flat and wavy curves. Mixtures of from 5-50 percent cyclohexene (in hexane) were next tested out to determine the feasibility of using this procedure for olefins (Figure 1). Later a series of tests were carried out with branched olefins such as nonene, tridecene and octadecene. The adsorption-affinity of the olefins is considerably less so that they emerge from the column much sooner; for instance, a 5 percent cyclohexene solution appears in about at the same time as does a 15 percent solution of benzole. Refractive indices of the olefins lie considerably below those of the aromatics; for this reason the olefin curves are easily distinguished from those of the aromatics.

The adsorption affinities of benzole and cyclohexene are about in the ratio of 6 : 4; it decreases to 6 : 3 in the case of branched olefins, with about a 6 : 2 ratio for octadecene, decreasing with increase in chain-length.

The relationships are quite different with active charcoal. Here the ratio of benzole to cyclohexene is 6 : 3, increasing, however, with the branched chain olefins; for instance, with nonene it is 6 : 2, and 6 : 8 with octadecene. We substantiate again previous observations that adsorption decreases with increasing chain-length using silica gel, while it increases with active carbon.

It might at first appear difficult to develop an analytical procedure for determining total olefin content, due to the variable behavior of the olefins;

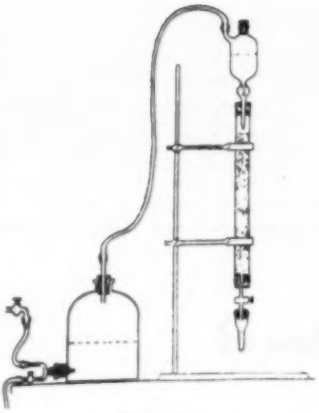


Figure 2.
Laboratory Apparatus.

however, the problem is simplified by noting that the olefns in question (as present in gasolines) range only from about six to ten carbon atoms; in this range variations are less pronounced. It is possible to obtain an average value which can be determined for the decreasing adsorption with silica gel, and increasing values for the charcoal (when molecular weights increase)—a value which might be fairly independent of molecular weight.

Our next problem was to determine the presence and quantity of olefins in mixture with aromatics. A series of runs were made using mixtures of benzole and cyclohexene in 1 : 3, 1 : 1, and 3 : 1 ratios, in concentrations of 5 to 50 percent in n-hexane. The curves obtained, Figure 1, are in all cases definitely step-wise, and even small amounts of olefins can be detected. Where the olefin content predominates, these hydrocarbons emerge relatively soon, the aromatics following later. The slope of the curve is quite steep at the olefin breakthrough, while it is negligible with the aromatics. The breakthrough point of the aromatics advances and the slope increases to a higher level with increase in aromatics, and decrease in olefin content. We also note a smaller or lower slope when olefins first come through. With mixtures of chain olefins, with increasing carbon atoms, similar displacements are obtained.

Basically, the behavior of several selected aromatics and olefins was established by their particular adsorption-affinities; the behavior of the saturated hydrocarbons, paraffns, isoparaffins, and naphthenes was next investigated. The latter groups exhibit only very weak adsorption tendencies, as compared with the olefins and aromatics. They are not separated in the adsorption column, but emerge as a mixture.

The small differences in their adsorption-affinities are only manifest due to the fact that the curve does not start as a straight line, becoming straight only after a slight rise or decline in curvature. This is due to the fact that the hydrocarbon of low adsorption affinity is initially enriched in the first cuts by elution. Using a mixture of saturated paraffins, such as pentane or hexane with active carbon one can note a curvature increase, due to selective adsorption, even though mild. This is due to a slight enrichment of the lower paraffins, and due to their lower refractive indices. It produces the characteristic slope seen in the diagram.

A reverse situation exists using silica gel, but less pronounced. Here the higher paraffins enrich the emerging fractions (higher refractive indices), resulting in a slight or unimportant curvature.

If the hydrocarbon mixture contains isoparaffins, such as iso-octane, a pronounced curvature is noted with active charcoal, since these hydrocarbons show the least affinity. Even cyclohexane shows less affinity with charcoal than does n-hexane, and emerges immediately from the column; the naphthenes behave similarly with charcoal, as in the case of the isoparaffins. When one employs the gel, which apparently is reactive toward double bonds, the small differences are practically impossible to observe.

Also of interest was to determine the effect of the molecular weight of the aromatics and olefins in mixture with paraffin hydrocarbons. It was shown that adsorption of benzole and olefins increases with increase in molecular weight of the paraffin hydrocarbon, using silica gel—both appearing later in equal concentration through the column; the reverse is the case with activated charcoal. We have already reported on this behavior. It would signify, for analytical purposes, that the curves are quite different, if we deal with quantities of aromatics and olefins in admixture with high and low molecular weight paraffins. This effect of molecular weight is obvious first of all only over wide ranges, and can be practically ignored in the case of the narrow range of gasoline; especially since the possibility exists to recalculate or convert the decrease (with charcoal) and increase (with gel) to an average value.

In order to round out this program experiments were next carried out with higher hydrocarbons. The results of this work will be reported at a later date; including descriptions of analytical procedures for diesel fuels, and

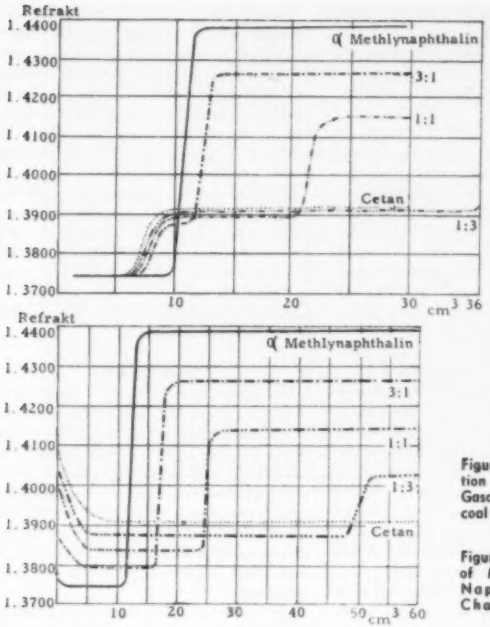


Figure 3 (Left). Adsorption of Mixtures of α-Methyl Naphthalene on Active Charcoal (upper) and on Silica Gel (lower).

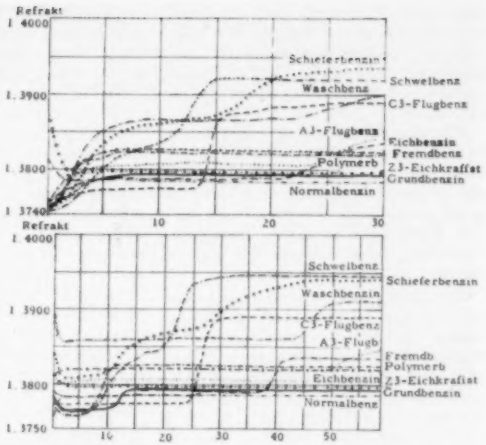


Figure 4 (Above). Adsorption Curves of Various Gasolines; with Active Charcoal (upper), with Silica Gel (lower).

mixtures of higher hydrocarbons.

Cetane is strongly adsorbed on active charcoal to about the same degree as benzole; for this reason benzole cannot be selectively separated from a diesel fuel oil for practical purposes. A-methyl naphthalene with its two unsaturated rings appears to be exceptional for obtaining a separation, and a typical curve. For instance, when using silica gel we find again an enrichment of cetane in the first cuts, and then a clean breakthrough of a-methyl naphthalene (Figure 3).

Determining Over-all Composition

A large series of various hydrocarbon mixtures were next investigated as to ease of separation of the components. After completing preliminary or exploratory work we prepared 15 typical gasoline mixtures composed of n-heptane, iso-octane, cyclohexane, benzole and cyclohexene. Starting with these known mixtures of common hydrocarbons the object was to determine their over-all composition. The typical gasoline mixtures were diluted 1 : 3 with n-hexane, a ratio found practical by trial and error; in the adsorption tests 25 grams of silica gel, or 12.5 grams of activated charcoal were employed. The solution in n-hexane minimizes to a great extent the mutual adsorption effects exerted normally by mixtures of the undiluted pure hydrocarbons. A maximum or sharp separation is obtained, which is especially sharp in the ranges of lower concentrations. Rather than presenting various diagrams and curves, we will discuss the highlights of the results obtained.

In the case using silica gel, n-heptane, iso-octane, and cyclohexane are not as much adsorbed as the solvent hexane, and therefore concentrate in the first cubic centimeters coming through. A rise in the curve results, most clearly discernible with cylohexane. With cyclohexene-hexane mixtures, there is no curvature as we expected, the breakthrough occurring at about 7 cc; with benzole the breakthrough occurs at 10 cc through. The curves for the aromatics are high and displaced to the right; the olefin curves are flat, and start to rise sooner. N-heptane and iso-octane, as well as their mixtures with cyclohexane and benzole yield curves descending at the start; initially ascending curvature is characteristic for all cyclohexane mixtures. Of importance is the "paraffin gradient"; we can describe it as the horizontal curve or line characteristic of the mixture of saturated hydrocarbons at the time of olefin or aromatic breakthrough. Valuable deductions can be derived from the refractive index and therefore from the position of this line concerning the paraffinic isoparaffinic or naphthenic character of hydrocarbon mixtures.

Meaningful deductions can be obtained from the activated charcoal curves. The heptane-hexane mixture yields curves start ascending, since heptane is more strongly adsorbed than hexane; iso-octane hexane mixtures are initially descending; this is also true for cyclohexene-cyclohexane mixtures. All mixtures containing iso-octane and cyclohexane show strongly descending curves at the start. One can definitely state that the basic hydrocarbon is a n-paraffin, when the adsorption curve shows a descent with silica gel, and ascent with activated charcoal. When the curve is descending using gel and charcoal, it indicates the presence of iso-paraffins. When the curve is ascending using gel, and descending with activated charcoal, it indicates that cycloparaffins are present. Benzole is strongly equal on both adsorbents; the curve ascendency is displaced to the right with mixtures of benzene homologues, and continues in wave-like form, due to selective action of the carbon. In the case of silica gel the benzene curve is coincident with homologue curve.

Figure 4 shows curves of a large series of determinations of various available gasolines. The curve for so-called "standard benzine or base" shows the characteristically descending shape given by the n-paraffins, with silica gel, the curve is ascending with charcoal.

The steep ascendency indicates high olefin content—probably mostly low molecular weight olefins, since with active charcoal they disappear completely together with the strongly adsorbed higher saturated paraffins. An analysis by the Kattwinkle method showed 9.6 percent olefins, 32.5 percent aromatics, and an iodine value of 64. The curve, nevertheless, definitely indicates that this gasoline contained no aromatics, only olefins. The high iodine value also indicates this.

The curve for "gasoline Z3" shows,

with silica gel, a weak, and with charcoal, a very strong descent. We have here a gasoline predominantly isoparaffinic. The olefin and aromatic content is 1 percent, no doubt due to experimental error.

The ascending silica gel curve shown by reference "Gasoline OZ 40" defies interpretation. The extended ascent of the activated charcoal curve signifies a relatively high content of n-paraffins. Olefins and aromatics are absent, even though the usual analysis showed 3.5 and 5.0 percent respectively.

The poly-gasoline investigated contains a high percentage of olefins, as shown by the silica gel curve; aromatics are absent. The paraffinic portion is in the low-boiling range, consisting probably entirely of n-paraffins. An analysis, for comparison, indicated 12.4 percent olefins, and 53.75 percent aromatics. Actually, aromatics are absent; the olefins present apparently are resistant to 90 percent sulfuric acid.

The leaded gasoline of unknown origin consists of a standard or base gasoline which is paraffinic plus added aromatics, and a small portion of olefinic material. Here again we find the chemical analysis giving a false picture.

The test showed 19.6 percent olefins and 6.5 percent aromatics. Aviation gasoline A-3 is similar except for a slightly lower aromatic content. Aviation gasoline C3 consists of a paraffinic base material with aromatic content of about 40 percent. The curve for activated charcoal shows that the addition of aromatics does not comprise only benzole, but also no doubt, a mixture of benzole, toluol and xylol. In this case the values obtained by chemical analysis appears to be approximately correct: 39.3 percent aromatics and 3.7 percent olefins. Probably the latter are not actually present. Compared with "gasoline A-3," the paraffin content is much lower. A so-called "washbenzine" is composed of a relatively high quantity of n-paraffins, with an appreciable aromatic content of some 20 percent, as shown by the high position, and steep decline of the curve with silica gel, and the long incline or ascent with active charcoal. The chemical analysis in this case agrees with these results by adsorption.

Shale gasoline 1, fraction between 266-392F, shows the characteristic picture of a mixture of olefins and aromatics. Compared with the other curves, the latter curve is elongated, with steep inclines. This is related to the fact that this gasoline contains no basic or simple aromatics but probably only such aromatics containing a small or large number of side-chains; the adsorption tendency of the latter are a disturbing factor. Nevertheless, one discerns clearly:

1) The curvature at the emergence of the olefins, and

2) The appearance of the aromatics by a like curvature.

The paraffinic base of this material shows again a high refractive index, due to the high boiling range of the benzine. With activated charcoal, a mixture of olefins and the higher paraffins is again indicated. Chemical analysis showed: 31.9 percent olefins and 30.2 percent aromatics. Agreement is hardly expected because the olefin content is certainly higher, being about two-thirds the sum of olefinic and aromatic material.

Cracked or benzene originating from certain tars[2] shows a very characteristic curve. The origin of the curve indicates that only the saturated portions consist of n-paraffins; in addition, the hydrocarbons are quite low-boiling, since the paraffin gradient is lower than any of the gasolines. Next is noted where the olefins emerge. This portion of the curve is not pronounced which indicates the presence of a large number of olefins of variable affinity. After a short break in the curve, we next note the emergence of the aromatics at the steep incline.

The previous curve given by the shale-oil gasoline indicated that the emergence of aromatics took place over an extended range. The cracked gasoline, however, yields the curve, under discussion, which shows a short and definite range or area when the aromatics start to emerge—as was the case with gasoline C-3, containing added aromatics.

It can be definitely concluded from this that the tar gasoline (or it may be of cracked origin) contains few aromatic groups, as shown by the active carbon curve.

The "normal benzene" (Schering) shows an ascending curvature with silica gel, and a descending curve with charcoal. As alluded to above, this points to the presence of naphthenes. A 12 percent naphthene content is permissible for this product.

Summary

The use of the adsorption method has been found feasible and of considerable value in the analysis of hydrocarbon mixtures.

For this purpose an apparatus was devised, and optimum conditions determined, in a large series of tests. The latter served as a basis in developing the method useful in analyzing a series of commercially available gasolines of various origin.

The possibility of separating and analyzing mixtures of high-boiling hydrocarbons will be discussed in a future article.

Generally it can be said that the aromatics and olefins can be determined by this method. It is also possible to assay gasolines for their content of "basic paraffins"; that is, is it composed basically of only the straight chain, branched chain paraffins, or also of naphthenes; this is qualitatively possible.

Further work is necessary to put the whole procedure on a strictly quantitative basis. However, there is already at hand, shown by the above results, a procedure which will yield a characterization curve for many types of gasolines, and which is most useful for identification purposes.

Discussion

K. Bratzler-Bartell and co-workers some 12 years ago[3] obtained S-shaped adsorption isotherms in their work with benzole alcohol mixtures. The absorbent adsorbs especially those components from both ends of the concentration range of a binary mixture, which are present in very low or lowest concentration. It appears it will adsorb just that which is present in least quantity.

If we employ silica gel instead of charcoal, adsorption appears to be reversed. One must consider here the spatial configuration of the molecule in relation to surface area of the adsorbent. For instance, work at the Mulheim Coal Research Institute some years ago revealed that it is possible to observe an hysteresis between ad and de-sorption isotherms during the adsorption of low-boiling paraffin hydrocarbons. The explanation given by the authors mentions that the paraffin molecules containing various chains are adsorbed at times parallel and at times perpendicular to surface of the adsorbent. Active charcoal particularly adsorbs the whole chain; with silica gel, the higher hydrocarbons due to side branching force the adsorption to take place perpendicular to the surface of the adsorbent.

In the case of silica gel, the higher hydrocarbons, with their branched chain structures, are adsorbed perpendicularly to the adsorbent surface; this is no doubt due to their very low affinity.

End of Part II and series.

BIBLIOGRAPHY

[1] See Part I. Erdoel & Kohle, 3, 120. (1950).

[2] Tests were made to confirm the fact that the olefin and aromatic emergence or breakthrough is always shown by this bend of the curve; cyclohexene and again benzole were added to the cracked and shale gasoline for this purpose. The curves show in all cases, that the olefin bend becomes broad and pronounced as in the olefin addition experiment; where benzole has been added, the olefin curvature seems to be less evident or obscured, and the aromatic portion of the curve becomes pronounced.

[3] F. E. Bartell & L. E. Lloyd, J. A. C. S. 60, 2129 (1938); F. E. Bartell & C. K. Sloan, J. A. C. S. 51, 1637 (1929); F. E. Bartell, O. Scheffler & C. K. Sloan, J. A. C. S. 53, 2501 (1931).

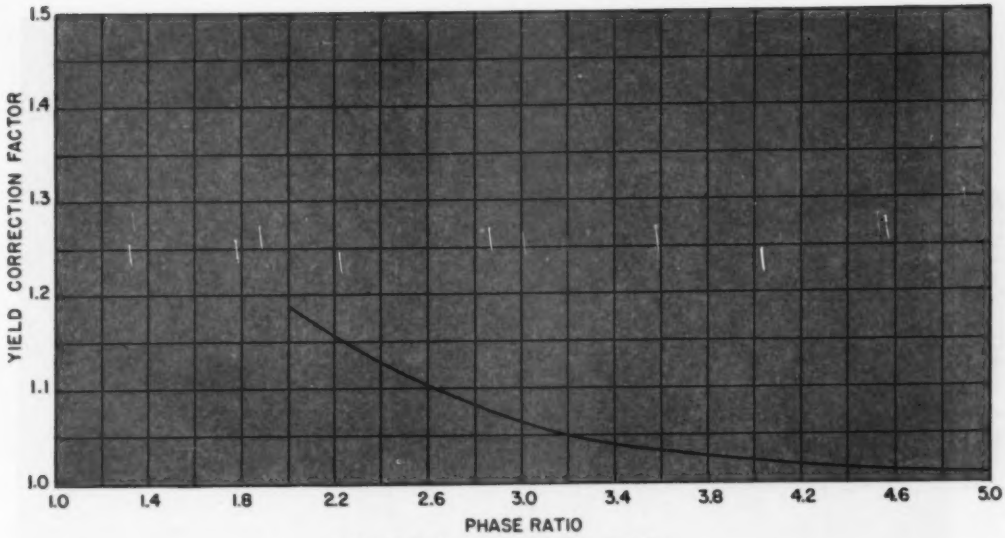


Figure 1. Yield correction curve for neutral oils.

CRUDE EVALUATION— Here Is An Approved Method

Procedure includes data on the solvent refining of both distillate and residual lubricating oils.

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Magnolia Petroleum Company,
Beaumont, Texas

A METHOD for evaluating crude oils of mixed and paraffin base was developed in the laboratory several years ago.* This method has furnished valuable information on many samples of crude oil. Supplementary improvements in this method have been developed which include solvent refining data on both distillate and residual lubricating oils. The improved procedure is presented here as a guide to other refiners that have the problem of evaluating crude oils.

Before a crude oil is adopted for processing in the refinery, it must be tested thoroughly to determine its usefulness. The methods employed, arranged in order of increasing magnitude and cost, are preliminary evaluation, pilot plant studies, experimental plant runs, and commercial production. Since the last three methods are quite expensive it is important that an inexpensive method of preliminary evaluation be employed. Such method should provide the maximum amount of data useful for estimating the yield and quality of finished product. A procedure which meets these requirements is described below.

Briefly the method consists of separating the crude oil by distillation into 375 F. end point gasoline, 520 F. end point kerosine, gas oil and an 80-second @ 130 F. lubricating oil distillate adjacent to a 540 F. flash point residuum.

If the inspections on these distillation products show that the crude oil is worth further study, the distillate and residual lubricating oil fractions are evaluated as follows:

The lubricating oil distillate is single-stage extracted employing 2 volumes of furfural at 210 F. This temperature was selected because it can be easily maintained in a steam jacketed vessel, and the volume of solvent represents a dosage requiring the least yield correction for viscosity index based on our furfural refining practices.

The furfural raffinate is dewaxed at 0 F. employing 400 percent by weight of a solvent mixture consisting of 40 volumes percent methylethyl ketone plus 60 volumes percent toluene. The method employed has been described in the literature* and is similar to that described in the procedure for determining the oil content of wax (ASTM D721-47). Dewaxing yields are calculated from the formula:

$$\text{Wt. \%} = \frac{\text{Wt. ratio of solvent to waxy oil}}{\text{Wt. ratio of solvent to dewaxed oil}} \times 100.$$

The 540 F. flash residuum is dewaxed first. The dewaxing procedure is the same as that described for the distillate oil fraction except that 5 weight percent of diatomaceous earth is used to facilitate filtering.

*See Bibliography, page 139.

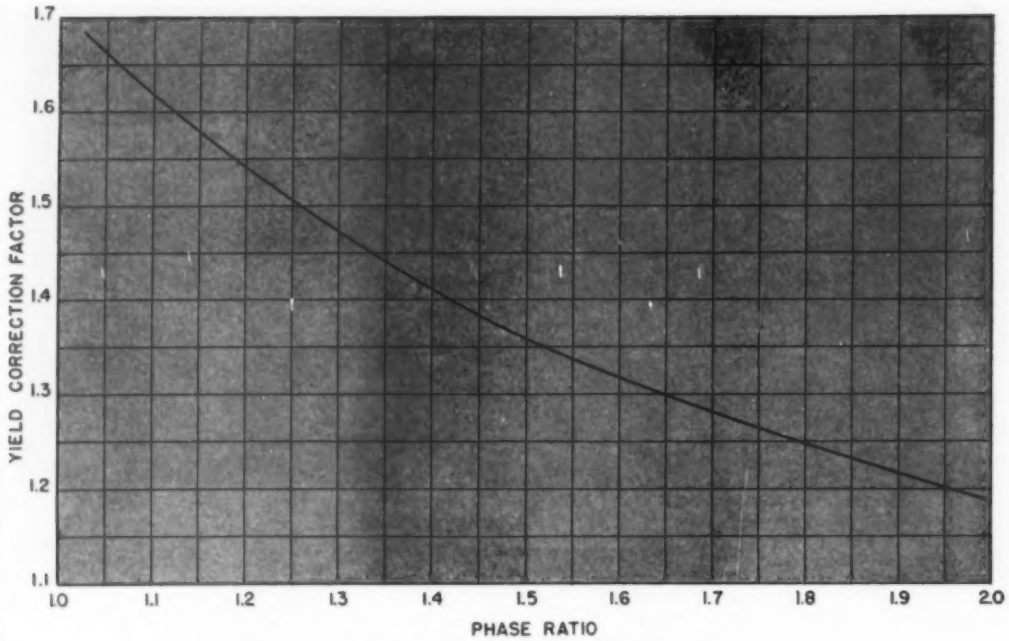

Figure 2. Yield correction curve for residual oils.

The dewaxed residuum is deasphalted at 90 F. employing 1000 weight percent of commercial grade fusel oil. The precipitated asphalt is washed with three 5.0 weight percent portions of fusel oil. Asphalt is separated by filtering through a half-inch layer of diatomaceous earth.

After deasphalting, the residuum is single stage extracted with 10 volumes of furfural at 210 F.

All measurements are made on a weight basis and converted to volumes for calculating yields.

Results obtained from treating the oils as shown above are interpreted by using the following assumptions:

1) The selectivity in a single stage solvent extraction is a function of the volume ratio of the solvent free oils present in the two phases formed.

2) Within a narrow viscosity index range, the relative distribution of the individual viscosity index constituents is similar for all crudes at their average viscosity index levels.

Validity of the above assumptions has been proven through experimental evaluations of many crude oils of variable viscosity index and composition characteristics.

On this basis the following procedure has been adopted for translating laboratory data to commercial operation.

TABLE 1
Viscosity Index Correction for Lubricating Oil Distillates

Desired V.I. Minus Adjusted V.I. from Item 4	Multiply Yield from Item 3 by
+10	0.72
9	0.75
8	0.78
7	0.81
6	0.83
5	0.86
4	0.89
3	0.92
2	0.94
1	0.97
0	1.00
— 1	1.03
2	1.06
3	1.08
4	1.11
5	1.14
8	1.22

The resulting figure represents the commercial furfural yield.

Lubricating Oil Distillate

1) Divide the percentage of furfural raffinate or extract, whichever is higher, by the percentage of extract or raffinate, whichever is lower. The resulting figure is referred to as "phase ratio."

2) Obtain the yield correction factor by referring to the curve shown in Figure 1.

3) Multiply the raffinate yield by this factor.

4) Adjust the viscosity index of the dewaxed raffinate to 20 F. pour test, if necessary, by adding 1 to the viscosity index for each 5 F. by which the pour is low, or subtracting 1 for each 5 F. by which the pour is high.

5) Adjust the yield from Item 3 to the desired viscosity index by using the factors in Table 1.

6) Multiply the percentage of wax *based on original lubricating oil distillate* by 1.67. This represents slack wax containing 40 percent oil.

7) Determine the dewaxing yield on the furfural raffinate from the following formula:

$$\text{Yield, Vol. \%} = \frac{\text{Laboratory Furfural Yield-Slack Wax from Item 6}}{\text{Laboratory Furfural Yield}} \times 100$$

8) Record the yields from Items 5 and 7. Assume a percolation yield of 98 percent and calculate yield based on distillate. Yields based on crude would be of doubtful value due to the difficulty of reproducing yields of a lubricating oil distillate in laboratory equipment.

Residium

1) Express the yields in terms of volume percent wax, asphalt, low viscosity index constituents and high viscosity index constituents.

2) Divide the percentage of high or

low viscosity index constituents, whichever is higher, by the percentage of low or high viscosity index constituents, whichever is lower, to obtain the phase ratio.

3) Obtain the yield correction factor by referring to the curve shown in Figure 2.

4) Multiply the yield of high viscosity index constituents from Item 1 by this factor.

5) Adjust the viscosity index of the high viscosity index constituents to 20 F. pour test, if necessary, by adding 1 to the viscosity index for each 5 F. by which the pour is low or subtracting 1 for each 5 F. by which the pour is high.

6) Adjust the yield from Item 4 to the desired viscosity index by using the factors shown in Table 2.

TABLE 2

Viscosity Index Correction for Residual Oil

Desired V.I. Minus Adjusted V.I. from Item 5	Multiply Yield from Item 4 by
+10	0.84
9	0.85
8	0.86
7	0.88
6	0.89
5	0.91
4	0.93
3	0.94
2	0.96
1	0.98
0	1.00
− 1	1.02
2	1.04
3	1.06
4	1.09
5	1.11

7) Add the percentage of wax from Item 1 to the yield from Item 6. The resulting figure represents the commercial Duo-Sol yield.

8) Multiply the percentage of wax from Item 1 by 1.18. This represents petrolatum containing 15 percent oil.

9) Determine the dewaxing yield on Duo-Sol raffinate from the following formula:

10) Record the yields from Items 7 and 9. Assume a percolation yield of 98 percent and calculate yields based on residuum and on crude.

The results obtained from this simple evaluation of crude oils are sufficient for deciding whether a certain crude oil is attractive for pilot plant studies. Comparison between the laboratory evaluations and commercial data are shown in Tables 3 and 4.

ACKNOWLEDGMENT

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TABLE 3

Laboratory Data on Refining Lubricating Oil Distillates from Six Crude Oils

CRUDE	A	B	C	D	E	F
Lubricating Oil Distillate						
Yield, Volume Percent of Crude	12.6	10.0	11.1	6.2	4.9	8.6
Gravity, °API	27.8	28.6	28.7	31.2	29.4	31.8
Pour, F	95	80	75	95	75	95
SUV at 130 F	79.5	80.0	79.5	79.5	79.5	80.0
Viscosity-Gravity Constant	0.841	0.836	0.834	0.818	0.829	0.813
Sulfur, Weight Percent	0.47	0.68	0.36	0.50	0.21	0.63
Laboratory Refined Distillate Oil						
Yields, Vol. Percent of Distillate:						
Wax	17.8	10.1	7.9	19.5	7.5	16.5
Low V.I. Oil	25.4	23.2	21.5	18.3	17.7	16.6
High V.I. Oil	56.8	66.7	70.6	67.2	74.8	66.6
Gravity, API	28.5	30.5	30.6	31.3	30.8	32.4
Pour, F	20	15	15	20	15	20
SUV at 100 F	173.8	145.5	148.9	164.2	136.7	147.6
SUV at 130 F	93.3	82.6	83.7	90.3	80.1	84.2
SUV at 210 F	44.3	42.7	42.8	44.3	42.6	43.7
Viscosity Index	90.2	94.8	91.7	102.3	107.8	113.4
Viscosity-Gravity Constant	0.832	0.822	0.820	0.815	0.821	0.810

Comparison of Commercial Refining Data with Laboratory Results Converted to Commercial Basis

	A		B		C		D		E		F	
	Lab.	Cml.	Lab.	Cml.	Lab.	Cml.	Lab.	Cml.	Lab.	Cml.	Lab.	Cml.
Yields, Vol. Percent												
Solvent Refining	60	61	82	80	57	60	65	65	76	75	70	67
Dewaxing	60	65	78	80	83	80	60	65	85	80	66	72
Percolation	98	98	98	98	98	98	98	98	98	98	98	98
Overall on Distillate	35	39	63	63	46	47	38	41	63	59	45	47
Properties												
Pour, F	20	20	20	20	20	20	20	20	20	20	20	20
Viscosity Index	99	99	95	95	104	104	110	110	112	112	119	119

TABLE 4

Laboratory Data on Refining Residua from Six Crude Oils

CRUDE	A	B	C	D	E	F
Residuum, 540 Flash						
Yield, Volume Percent Crude	19.9	19.0	23.4	25.0	20.8	16.4
Gravity, °API	17.0	20.0	20.7	22.7	20.2	20.3
Flash, °F, COC	540	545	540	540	540	540
Pour, °F	120	50	65	85	45	80
SUV at 210° F	314	204	208	213	175	143
Ramsb. Carbon Res	7.7	5.6	5.2	5.6	5.3	5.6
Viscosity-Gravity Constant	0.872	0.853	0.848	0.832	0.854	0.841
Laboratory Refined Residuum						
Yield, Vol. Percent of Residuum:						
Wax	12.4	7.8	4.7	18.7	1.8	11.0
Asphalt	17.2	11.5	10.5	21.1	12.1	16.8
Low V.I. Oil	40.8	36.1	39.6	26.7	40.3	28.7
High V.I. Oil	29.6	44.6	48.2	33.5	45.8	43.5
Gravity, °API	24.8	26.2	26.2	27.3	25.6	28.0
Pour, °F	40	25	20	25	20	15
SUV at 100° F	2216	1943	2272	1640	1587	1079
SUV at 210° F	130.8	127.1	139.8	122.5	120.2	97.1
Viscosity Index	87.0	93.6	93.8	101.5	101.8	103.8
Viscosity-Gravity Constant	0.824	0.814	0.813	0.806	0.819	0.805

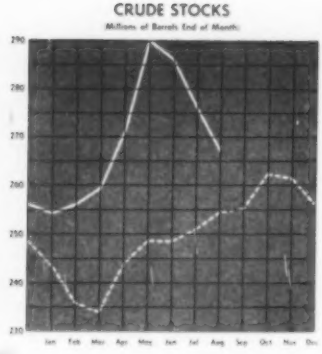
Comparison of Commercial Refining Data with Laboratory Results Converted to Commercial Basis

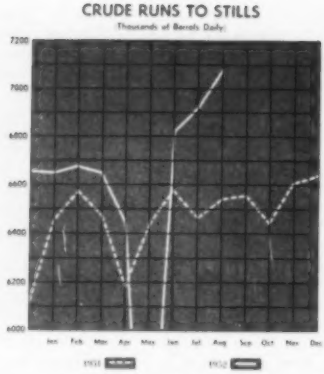
	A		B		C		D		E		F	
	Lab.	Cml.	Lab.	Cml.	Lab.	Cml.	Lab.	Cml.	Lab.	Cml.	Lab.	Cml.
Yields, Vol. Percent												
Solvent Refining	48	48	71	70	71	70	66	67	73	73	71	74
Dewaxing	89	91	87	84	92	84	87	70	97	87	82	75
Percolation	98	98	98	98	98	98	98	98	98	98	98	98
Overall on Residuum	32	29	61	58	64	59	43	46	69	62	57	55
Properties												
Pour, °F	20	20	20	20	20	20	20	20	20	20	20	20
Viscosity Index	93.0	93.0	97.0	97.0	97.0	97.0	104.0	104.0	104.0	104.0	104.0	104.0

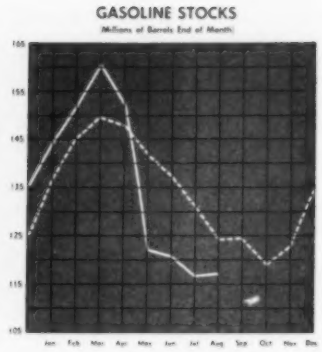
FORMULA 3

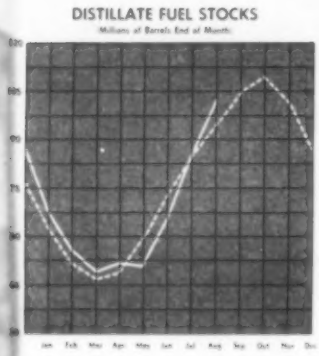
$$\text{Yield, Vol. \%} = \frac{\text{Commercial Duo-Sol Yield from Item 7} - \text{Petrolatum from Item 8}}{\text{Commercial Duo-Sol Yield from Item 7}} \times 100$$

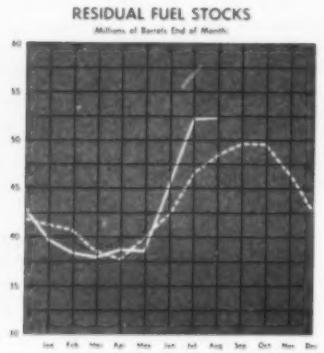
* * *

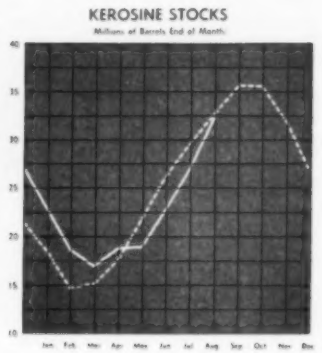












Taking Stock

Cecil W. Smith
Economics Editor

(DATA IN THOUSANDS OF BARRELS)

	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
B MONTH	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Daily	Production Month	Stocks End of Month	Production Daily	Stocks duction Month	Crude Oil	Total Oils
1951:													
February	5,930	6,562	235,247	2,908	145,184	410	14,776	1,419	51,348	1,382	40,716	468	937
March	6,052	6,469	233,824	2,908	149,679	399	15,135	1,327	46,744	1,348	38,366	453	861
April	6,127	6,183	243,180	2,821	147,679	384	17,639	1,171	48,239	1,230	37,623	511	871
May	6,170	6,436	248,418	3,031	141,658	345	21,974	1,210	59,272	1,265	39,879	518	876
June	6,130	6,575	248,170	3,100	137,009	317	26,206	1,254	72,140	1,277	42,398	563	876
July	6,141	6,462	250,847	3,091	130,931	341	29,679	1,228	84,282	1,275	46,320	546	788
August	6,232	6,539	254,276	3,114	124,202	339	32,728	1,237	94,028	1,226	48,365	529	780
September	6,261	6,558	254,900	3,127	124,530	364	35,773	1,282	104,082	1,228	49,608	500	744
October	6,375	6,446	262,266	3,105	118,864	363	35,739	1,295	109,544	1,224	49,573	421	769
November	6,272	6,609	261,100	3,130	122,723	403	32,116	1,358	101,666	1,304	46,431	425	802
December	6,182	6,646	255,783	3,150	134,867	393	27,088	1,442	89,619	1,313	42,853	423	834
1952:													
January	6,217	6,640	254,007	3,094	144,339	421	22,679	1,456	66,969	1,338	39,523	488	951
February	6,367	6,673	255,900	3,109	151,912	370	18,530	1,528	55,369	1,322	38,295	491	940
March	6,388	6,640	259,126	3,069	160,689	389	16,817	1,400	48,750	1,274	37,971	510	947
April	6,429	6,435	270,679	2,995	151,890	366	18,955	1,312	51,634	1,253	38,561	579	922
May	5,107	4,993	290,813	2,295	123,656	229	19,614	982	51,648	979	38,821	545	951
June	6,197	6,825	285,964	3,169	129,166	317	23,961	1,455	65,911	1,228	45,688	581	911
July	6,003	6,927	275,951	3,295	116,566	358	27,387	1,475	85,775	1,237	52,245	597	892
August	6,274	7,086	266,454	3,326	117,181	375	32,265	1,473	102,871	1,267	52,436	647	876
August, 1952—Change:													
In Month	+181	+159	−9,497	+31	+615	+17	+4,878	−2	+17,096	+30	+191	+59	−16
In Year	+42	+547	+12,178	+212	+7,021	+36	−463	+236	+8,843	+41	+4,071	+118	+96
Week Ended:													
9-20-52	6,514	7,060	264,406	3,426	118,315	390	34,680	1,468	112,472	1,218	53,484	661	933
9-22-51	6,208	6,530	252,569	3,107	123,120	342	35,888	1,364	102,334	1,194	48,724	635	849

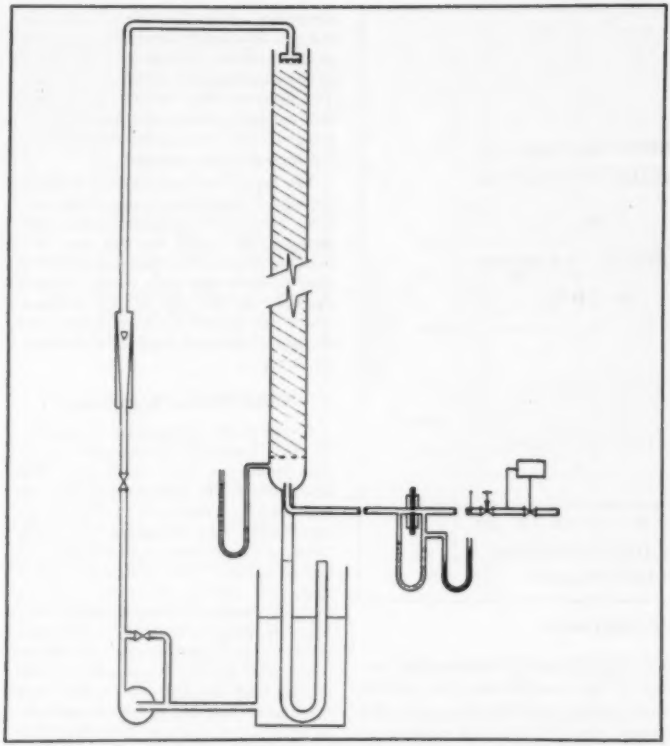


Figure 1. Schematic diagram of equipment used in experiments.

How Surface Tension Affects Flooding in Packed Columns

Experimental data obtained with surface active agents provide basis for new correlations

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THE CAPACITY of a packed column used for counter current contact of a liquid and a gas is limited by the tendency of the column to flood when the liquid or the gas rate reaches a certain velocity, termed the flooding velocity. The point at which flooding occurs is a function of the liquid and the gas velocities, and the column may flood over a rather wide range of both. While it may be possible to operate a distillation or absorption column at flow rates greater than those of flooding, the efficiency drops rapidly at the flood point and also the pumping costs increase so that this is the limit for most practical operations. In spite of the large amount of work which has been done on this subject in recent years, the general correlations that have been developed do not predict flooding, under a wide range of conditions, as closely as is desirable for design purposes. All dissolved substances are to some extent surface active and affect foaminess. In the design of packed towers, due consideration should be given these effects.

White[10] has defined both a loading point and a flooding point which are determined by plotting the log of the pressure drop per foot of packing height against the log of the gas rate. A curve composed of three straight lines of different slopes is usually obtained, with two regions where the slope is indeterminate. The loading point, according to White, is the intersection of the lower and middle straight segments, or that point at which the slope becomes greater than two. The flood point is that point at which the slope becomes practically infinite. For any liquid rate there is a corresponding loading and flooding point. Under certain conditions, the loading and flooding points were found by White to coincide. This was also noted by Bain and Hougen.[1]

The visual flood point has been defined in several ways. The gas velocity for a given liquid velocity at which the liquid begins to spray out of the top and is mechanically carried up out of the packing by the gas stream was used by Sherwood, et al.,[9] while Sarchet[7] and also Shoenborn[8] took as flooding that conditions under which the liquid level built up to a height of one-half inch above the packing.

Some writers[1,2] contend that the graphic method gives more consistent results than the visual method and that the graphic flood point is the true flood point. In this study, the flood point was determined both by the graphic method of White and by observation. However, visual flooding as defined by Sarchet was found to coincide very closely with flooding as determined by the graphic method.

Sherwood, and co-workers, developed a correlation that is widely used for design purposes, and which takes into account the physical properties of the liquid and gas phases, but stated that the surface tension of the liquid is not a factor in flooding. They used pure methanol, and aqueous solutions of both methanol and butyric acid to obtain surface tensions below that of water for the liquid phase.

Lobo, et al.,[5] reviewed all of the literature available and by a careful evaluation of the properties of the packed section (its porosity, surface, etc.) obtained a correlation of the Sherwood type which showed improved consistency of values.

Zenz[11] has presented a theory of flooding which is based on an analogy to the flow of fluids through valves and orifices.

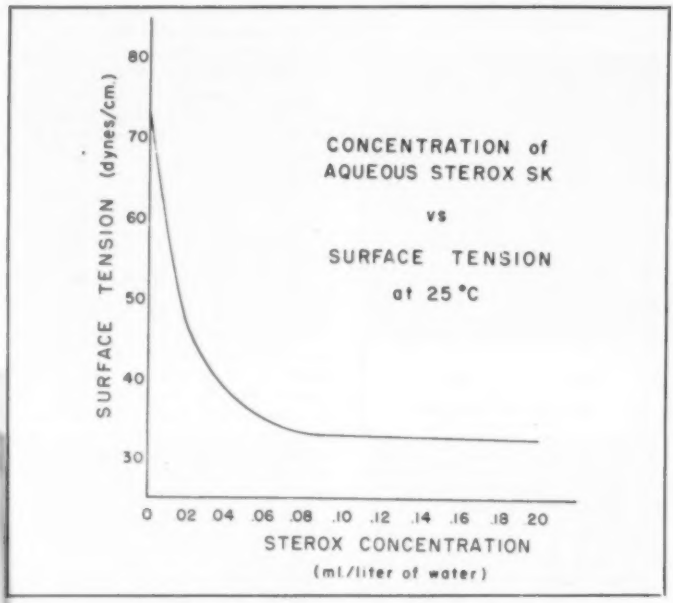

Figure 2. Effect of Sterox on surface tension.

Lerner and Grove[4] have advanced the theory that loading and flooding in packed columns are caused by wave formation in the liquid.

A rather comprehensive study of flooding in packed columns is nearing completion in the chemical engineering laboratories at Georgia Tech, which includes the investigation of the following variables: column height, column diameter, size of packing, type of packing, surface tension of the liquid, and the properties of the surfaces of the packing and of the column walls.

This paper embraces a study of the effect of surface tension values which are abnormal to the pure liquid in that they are due to relatively small amounts of incidental solutes. Water was used as the solvent in the liquid phase and air as the gas phase. These lowered surface tension values are shown to have a predominant effect upon the flooding characteristics of packed columns when caused by certain types of surface active materials. Both ionic and non-ionic surface active agents were used. A correlation of the Sherwood type including the fractional lowering of the surface tension is presented.

Equipment and Materials

The column consisted of two four-foot lengths of four-inch-diameter tubing, sealed together with mastic and mounted vertically by using a plumb bob (See Figure 1). A seven-foot section of new one-half inch Berl saddles, supported on one-half-inch mesh wire screen, was put into the column by dropping, piece by piece, into the column filled with water. The porosity of this bed was determined to be 0.652 and no subsequent settling occurred. The pressure drop across the packed section during flow was measured by a water filled manometer connected to the bottom of the column.

The liquid was contained in a closed system. A centrifugal pump took suction from the column sump and pumped the liquid through one of a bank of three rotameters (of different sizes to cover the wide range of flows desired) to the top of the column, where the stream was distributed over the top of the packing by the distributor head.

ASME Orifice Installation

A two-stage compressor (capacity-37 cfm) furnished air through a pressure regulating valve at 75 psig. The flow through the calibrated orifice was regulated by a needle valve. The orifice installation was according to ASME "Special Committee for Fluid Meters"[3] specifications. Two different orifice sizes were used to allow measurement over the range of flows desired. The pressure drop across the orifice was measured by a glass U-tube manometer filled with water. The density of the air passing through the orifice was calculated from the upstream pressure, as noted on a mercury filled manome-

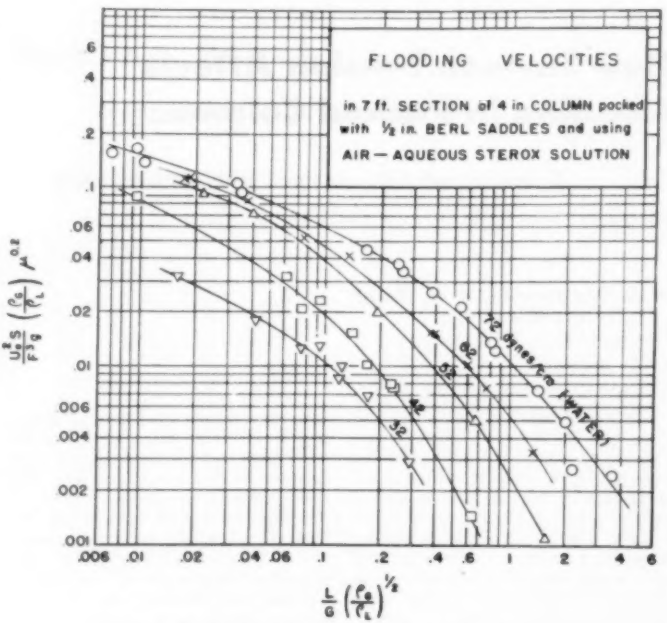

Figure 3. Experimental results shown on Sherwood-type plot.

TABLE OF NOMENCLATURE

F	Fractional free void volume of packed section, percent
g	Gravitational constant, ft./sec^2
G	Superficial* gas mass rate, lb/sec. ft.^{2}
L	Superficial* liquid mass rate, lb/sec. ft.^{2}
S	Surface area of packing, ft.^{2}/ft.^{3}
U_o	Superficial* linear gas velocity, ft./sec.
ρ_G	Density of gas, lb./ft.^{3}
ρ_L	Density of liquid, lb./ft.^{3}
σ_w	Surface tension of water, dynes/cm.
σ	Surface tension of solution, dynes/cm.
μ	Viscosity of liquid, centipoise

* Based on the cross sectional area of the empty column.

ter, and the temperature, measured by a mercury thermometer installed in the air line upstream of the orifice. A cyclone type separator and a fiber glass filter in the supply line assured that the air was delivered dust and condensate free.

The liquids of the various surface tension values were prepared by addition to water of varying amounts of Sterox SK, a condensation product of ethylene oxide and dodecyl mercaptan, furnished by Monsanto Chemical Company of St. Louis. The surface tension values were determined by use of an interfacial tensiometer. In all cases the amounts (indicated in Figure 2) of Sterox required were found to be insufficient to cause a noticeable change in the physical properties of the water, i.e., density, viscosity.

Procedure

Each determination of flooding rate consisted in establishing a constant measured rate of liquid by means of the rotameter, and then raising the gas rate in small increments until flooding occurred. Each gas flow rate was maintained constant, as measured by the pressure drop across the calibrated orifice, until steady state was assured by constancy of the pressure drop across the packed section. The time required for the attainment of steady state varied from 10 minutes to as much as one hour. The White[10] definition of the flood point was accepted and in each case a sharp break was noted in the curve of log of pressure drop versus log of gas mass flow rate.

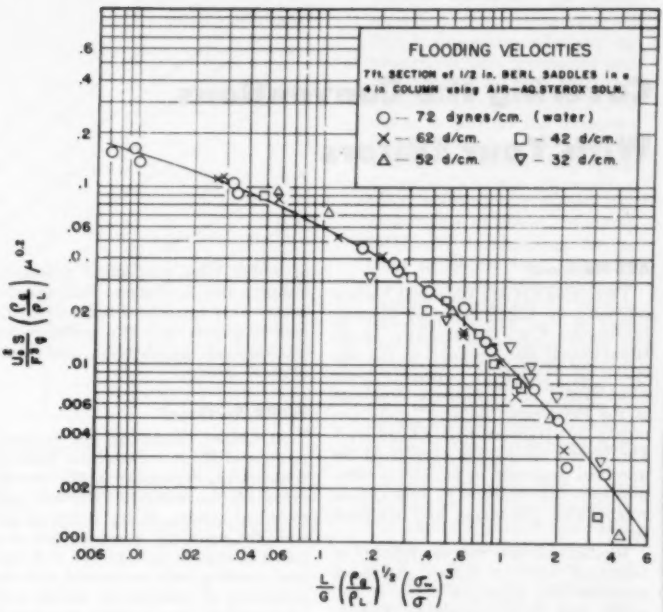

Figure 4. Experimental results shown on modified plot including surface tension term.

Results and Discussion

It was found that variation of the surface tension of the liquid caused by the addition of certain surface active agents to water, had a marked effect on the flooding velocities in packed columns. Sterox, Aerosol OT (dioctyl sodium sulpho succinate) and sodium oleate were used as additives. The data for all three additives were in quite good agreement. The data obtained using aqueous solutions of Sterox are shown, in a plot of the type used by Sherwood, et al., as a series of curves in Figure 3 from which the magnitude of the effect of surface tension may be readily seen. Figure 4 shows the same data on the same type of plot with the exception that the abscissa includes as a factor the cube of the ratio of surface tension of water to that of the solution. The data for surface tension ranging from 32 to 72 dynes per cm correlate well.

Liquids of the same surface tension do not necessarily exhibit the same flooding characteristics. Flooding is a function not only of surface tension but also of a number of other factors including foaminess and foam stability. Foaminess measurements using the method of Ross[6] show that the foaminess of methanol, methanol and water, and butyric acid and water solutions are very low as compared to the foaminess of the solutions used in these experiments which are of the same order of magnitude.

Conclusions

There is an effect upon flooding in packed columns caused by the presence of surface active materials which for materials similar to those used in these experiments can be correlated by introducing the cube of the ratio $\frac{\sigma_w}{\sigma}$ as a factor into the abscissa of a Sherwood type of plot, but the effect of the surface active materials involves other factors than surface tension because surface tension does not correlate the data for all such materials.

The results indicate that foaminess is a factor in flooding of packed columns.

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[11] Zenz, F. A., Chem. Eng. Prog. 43 415-28 (1947).

Covering the Conventions With Your Editors

ACS National

THE AMERICAN Chemical Society convened its 122nd National Meeting in Atlantic City, September 14-19. Highlighting the meetings of the Division of Petroleum Chemistry were symposiums on "Unsolved Problems of the Petroleum Industry" and "Catalysis in Hydrocarbon Chemistry." The former symposium considered the unsolved problems in petroleum composition, oil recovery, lubrication, combustion, processing and synthetic fuels.

Predictions were that the refinery of tomorrow will be bigger and more complex with extensive usage of catalytic and fluid principles. Specifically, catalytic improvements can be expected in: 1) mild hydrogenation of petroleum fractions for improving stability and sulfur removal, 2) operations for octane improvement extended to lighter naphtha fractions, 3) hydrogenation operations for converting heavy residual oil fractions to lighter products, and 4) yields of oil products from natural gas, oil shale, tar sands and coal.

Of particular interest to refinery chemists was the presentation of a new method for determining tetraethyl lead in gasoline by the use of a flame photometer. Analysis can be accomplished in five minutes with an accuracy of 0.01 ml per gallon.

ISA Meet and Exhibit

More than 9000 instrument engineers, mechanics, and technicians at the seventh annual ISA instrument conference and exhibit heard in excess of 100 technical papers that touched on all phases of the instrumentation field. Nearly 200 manufacturers displayed a glittering array of over $10 million worth of the latest developments in commercial instruments.

The convention was preceded by a three-day Instrument Maintenance Clinic sponsored by ISA and held at the Case Institute of Technology. The clinic is dedicated to improving the skill of the apprentice instrument technician.

The technical program was divided into several sections, the leading ones of which were production processes, testing, and operation and maintenance. Very specialized fields were covered in papers on instrumentation for the medical, geophysical, and aeronautical groups.

WPRA Sectional

At Casper, Wyoming, the regional meeting of Western Petroleum Refiners Association, September 25-26, was divided into an industrial relations and technical session. In the technical session, the principal questions put to a panel of experts on catalytic and thermal cracking were concerned with the poisoning of catalysts by metals such as vanadium, iron, copper and nickel. A spokesman for the instrumentation industry predicted the following trends in refinery instrumentation: 1) Electric power systems favored over pneumatic systems, 2) closer approach to end point analysis, and 3) use of servomechanism theory in design.

The industrial relations session considered departmental organization, employe benefits, current hot spots in labor relations, and du Pont's Hobso system. The speaker on employe benefits emphasized that the value of such programs depends on the understanding the employe has of the benefits.

ASME Petroleum Division

The seventh annual ASME convention featuring petroleum mechanical engineering was in session on September 22-24. All phases of refinery engineering were covered in the 39 papers presented. Of particular interest to PETROLEUM REFINER readers was the symposium on maintenance of refinery units during operation. The suggestions offered in the four papers included tips on manpower allocation and scheduling, equipment requirements, and solutions to special problems.

Engineering design problems and accomplishments were the theme of several papers. In this group were discussions of the design features of two recently developed catalytic cracking processes, packaged gasoline plants, and direct-fired heaters.

AIChE Annual

The American Institute of Chemical Engineers held their annual meeting in Chicago, September 11-13. In honor of the centennial of engineering, the meeting opened with a special symposium designed to illustrate the contributions of the Chicago area to chemical engineering. The opening paper, delivered by Dr. R. C. Gunness, Standard Oil Company (Indiana), was titled "The Fluidized Solids Technique in the Petroleum Industry." He pointed out that the refineries are now producing more gasoline at a lower cost than ever before from crude oil components.

A second symposium covered the new techniques of mixed-bed ion exchange. Joseph Thompson, Rohm and Haas Company, described a new system of ion exchange equipment which would cut operating costs and also cut the size of water purification plants. M. E. Gilwood, The Permutit Company, compared the costs and effectiveness of silica removal by mixed-bed and two-step ion exchange demineralization of boiler feed water.

In a general paper C. A. Velz, from the School of Public Health of the University of Michigan, warned the nation that industrial expansion is at such a point now in the United States where no new plants may be built without the consideration of the waste problem. He said "there was a time when water supply intake was the important factor, but today the limiting criterion is safe disposal of wastes."

NPA Annual

Celebrating its 50th anniversary, National Petroleum Association met in Atlantic City, September 10-12. High interest centered on the symposium "Jet Fuels—Present and Future." Composed of two refiners, two aircraft, and two government spokesmen, the panel agreed that fuel supplies for jet planes are adequate at the present time, but small refiners can contribute much to the nation's defense effort—and help themselves at the same time—by turning more and more to the production of jet fuels. The small refiners can manufacture jet fuels without difficulty, because it does not require the extensive and expensive equipment needed to blend and process high-octane aviation gasoline. In addition to increasing the fuel supplies, they can help the distribution problem through the diversity of their geographical locations. This will have far-reaching implications in the event of an all-out emergency. The panel concurred that jet fuel needs for peacetime commercial aviation will require only a fraction of available oil supplies over the next decade.

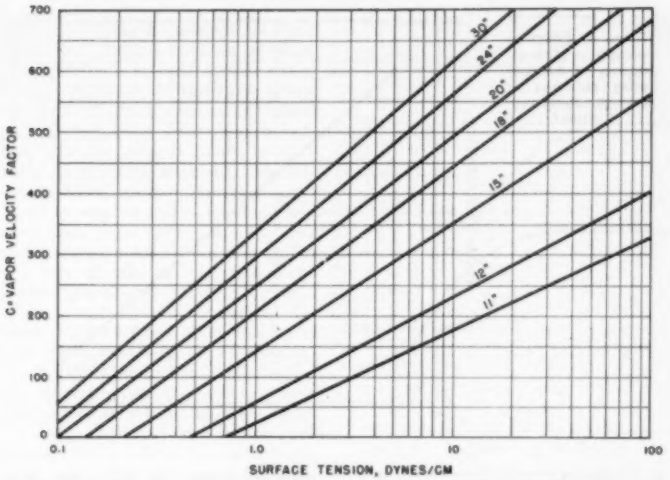

Figure 1. Bubble cap plate, column diameters. Values of C for equation: $W = C\,[d_2(d_1-d_2)]^{1/2}$; d_1 = Den. Liquid. lb./ft.^{3} d_2 = Den. Vapor, lb./ft.^{3}; w = Allowable Mass Vel. lb./ft.^{2}/hr. Data from: Souders & Brown, Ind. Eng. Chem. 26, 98 (1934).
1) For Absorbers, multiply C by 55; 2) For fractionating section of absorber oil stripper, multiply C by 80; 3) For petroleum column, multiply C by 95. 4) For stabilizers, multiply C by 1.16.

THOSE DESIRING an understanding of distillation will find in this series a helpful approach to this important unit operation. The first impulse for men in the technical brackets is to turn to the literature for an understanding of this subject; but unless they spend a considerable amount of time, absorbing theory and repetitions of theory, their efforts may be fruitless. In the case of technicians, foremen and operators, their efforts are usually confined to asking questions. Since the distillation literature is more than 25 years old, it is difficult for new men to familiarize themselves with the subject and since little has been devoted to actual practice, their questions may go unanswered.

Beginning with Part I (August issue) this series outlined the high points of distillation as applied to actual practice. Part II is devoted to an elementary discussion of bubble cap and packed distillation columns.

Applied Distillation

Part II. Bubble Cap and Packed Distillation Columns.

High points of distillation applied to actual practice give familiar approach to this unit operation.

K. E. Coulter
The Dow Chemical Co.
Midland, Mich.

Bubble Plate Distillation Columns

MOST DISTILLATION columns in industry are bubble plate or packed. Bubble plate columns are used on most major installations and will be discussed first.

Topics regarding bubble plate column operation will be covered as follows:

1) Allowable mass vapor velocities
   a) Effect of pressure
   b) Effect of plate spacing
   c) Effect of surface tension
   d) Equation for calculating mass vapor velocity
2) Bubble plate efficiencies
   a) Effect of viscosity
   b) Effect of vapor velocity
   c) Effect of diameter
   d) Effect of foaming
3) Effect of feed temperature on liquid and vapor velocities
4) Plate spacings
   a) Startup procedure

Allowable Mass Vapor Velocity—One item in operation of distillation columns is the allowable vapor velocity. This subject was investigated by Souders and Brown,[12] using commercial and laboratory columns. Their data correlation used vapor and liquid density, plate spacing, and liquid surface tension as variables. Recommended vapor velocities were slightly lower than those where entrainment of liquid from plate to plate was such that plate efficiencies were reduced. The Souders and Brown equation[13] is as follows:

$$W = C\left[d_2\ (d_1 - d_2)\right]^{1/2}$$

Where:

W = allowable mass vapor velocity in pounds per hour per square foot of total cross sectional area in the tower.

C = a constant depending on the sur-

TABLE 1
Calculation of Allowable Mass Vapor Velocities in an 18-inch tray spacing ethyl benzene column

Pressure mm Hg	Temp °C	Liq. Density lbs/ft^3=d_1	Vap. Density* lbs/ft^3=d_2	Surface Tension Dynes/cm	C	$d_2(d_1-d_2)$	$\left[d_2(d_1-d_2)\right]^{1/2}$	W—Allowable Mass Vapor Velocity lb./ft^2/Hr
760	136.5	47.7	0.1965	17.4	495	9.34	3.055	1512
380	112.5	49.1	0.1044	19.8	508	5.12	2.262	1152
190	91	50.4	0.0553	21.7	518	2.785	1.669	864
95	72	51.4	0.0292	23.7	525	1.5	1.224	642
47.5	56	52.3	0.0153	25.1	534	0.8	0.894	476
23.75	41.2	53.1	0.00797	26.8	540	0.424	0.65	352
5	13	54.7	0.00186	29.8	550	0.102	0.32	176

* Calculated using Ideal Gas Laws.

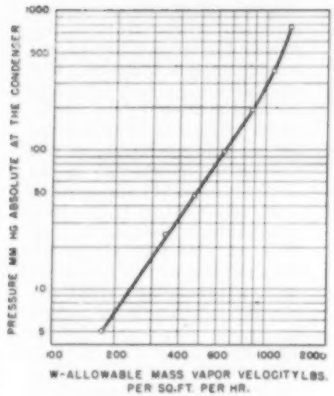

Figure 2. Ethyl benzene column.

face tension of liquid on the plate and plate spacing.

d_2 = vapor density under operating conditions in pounds per cubic foot.

d_1 = liquid density under operating conditions in pounds per cubic foot.

Their data are shown in Figure 1. Surface tension is plotted on the *X*-axis vs. *C* values on the *Y* axis for lines of constant plate spacing. It is evident from Figure 1 and equation 1 that large plate spacing increases *C* and allowable mass vapor velocity. For example, a column with 18-inch plate spacing has a *C* of 510 whereas a column with 12-inch plate spacing has a *C* of 275, when liquid on the plate has a surface tension of 20 dynes.

It is interesting to compare effect of pressure on allowable mass vapor velocity in commercial units. Assume ethyl benzene at various temperatures and pressures. Calculations are presented in Table 1 and Figure 2 for values of *W* ranging from 1512 to 176 in the pressure range from 760 mm to 5 mm of mercury absolute.

Surface tension has considerable effect on *W*, for example a column with 18-inch tray spacing has a *C* of 510 at a surface tension of 20.0 dynes per cm. and 174 at 0.75 dynes per cm. 0.75 dynes per cm. is the lowest surface tension for which the author has used the correlation.

Summarizing factors effecting vapor velocity in bubble plate columns, it may be said, within limits, increases in pressure, surface tension and plate spacing tend to increase allowable vapor velocity, providing sufficient liquid carrying capacity is present.

Plate efficiency has been invstigated by a number of authors and viscosity of the liquid, vapor velocity, tower diameter and foaming are variables which effect it.

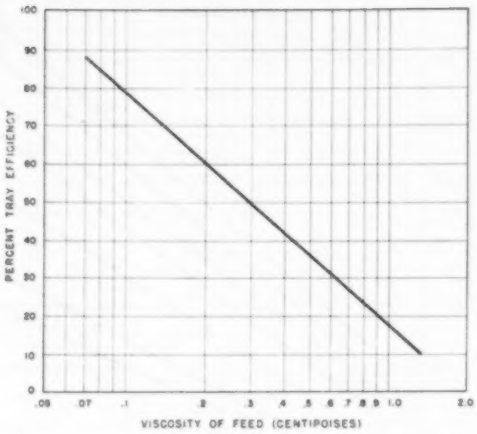

Figure 3. Effect of viscosity on plate efficiency of fractionating columns at average column condition.[4]

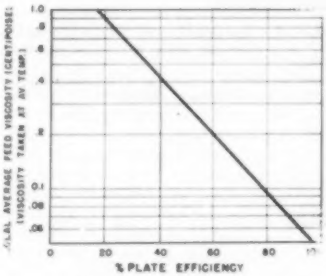

Figure 3a. See Reference 4.

Bubble Plate Efficiencies—Drickamer and Bradford[4] and O'Connell[10] investigated viscosity and found a correlation when the logarithm of feed viscosity, at average tower temperature, was plotted versus plate efficiency. The data of Drickamer and Bradford[4] is plotted in Figures 3 and 3a. O'Connell[10] found columns operating with high relative volatilities (systems which have liquid-vapor equilibrium curves at a considerable distance from the 45° line) tend to have low plate efficiencies and plotted plate efficiency versus logarithm of feed viscosity times the relative volatility of the key components. Effect of relative volatility was noted by Gester[6] in dehydration of n-hexane. Gester found plate efficiencies in the order of 4-7 percent.

Brown and Lockhart[3] investigated effect of vapor velocity on plate efficiency and found the Souders and Brown[12] equation useful in predicting the range of vapor velocities which gave maximum tray efficiencies. The authors[3] found low plate efficiencies at abnormally low vapor velocities and a gradual rise with increased vapor velocity until maximum efficiency was attained. Above this velocity efficiency remained constant until vapor velocity exceeded 125-130 percent of the value calculated, then a gradual decrease was noted (Figure 4). Note plate efficiency remains essentially constant at vapor velocities of 80-130 percent of the calculated value. In plant operation the operator should be sure the reboiler and condenser on the column are of sufficient size to attain a velocity near the value predicted by the equation and should operate in the range of maximum tray efficiency.

Drickamer and Bradford[4] noted large diameter columns had higher plate efficiencies than small columns. Their correlation was for columns having liquid paths of 2½ feet, whereas columns 12 feet and 14 feet in diameter gave plate efficiencies 7.5 and 16 percent higher than predicted. The increase caused by increased liquid path is shown in Figure 5.

Foaming effects the plate efficiencies and may force the designer and operator to use wide tray spacings and/or anti-foaming agents. Serious operational difficulties may result from foaming caused by slight impurities in the material being distilled.

Plate Spacings—Plate spacings in bubble plate distillation columns have

TABLE 2
Comparative Allowable Vapor Velocities in Bubble Tray Columns

Plate Spacing Inches	$\left[\frac{d_2(d_1-d_2)}{\quad}\right]^{1/2}$	Surface Tension Dynes/Cm	C	W
11	3.05	20	222	680
12	3.05	20	275	840
15	3.05	20	414	1260
18	3.05	20	510	1560
20	3.05	20	564	1720
24	3.05	20	644	1970
30	3.05	20	700	2140

been a controversial subject. Souders and Brown[6] indicate columns of large plate spacing have considerable more capacity than those of small tray spacing (Table 2). Old columns had plate spacings as low as 7 to 8 inches but later columns usually have considerably more tray spacing. Several authors have reported improved performance on low plate spacing columns when every other plate was removed. Figure 6 may serve as a guide as to why columns of low plate spacing are undesirable from the standpoint of capacity and operation. As shown, liquid on the plate backs up in the downcomer a height *H*, because of pressure drop through the chimneys, bubble caps, and downcomers. Backup equals total pressure drop plus the liquid level on the plate. If a column has a low plate spacing and liquid has a tendency to foam, no definite liquid level is obtained and no definite separation between the plates is obtained. Various ideas as to the distance from the top of the liquid to the next plate have been given. Some designers[8] use twice the *H* value (plate spacing equals 2H) and others at least 10 inches. If a minimum of 10 inches is used, minimum tray spacing would be about 13 inches. Unless *H* is greater than the pressure drop through the chimneys, caps, and liquid on the plate slight changes in vapor velocity will break the seal in the downcomers. After the seal is broken liquid cannot get down the column, the reboiler and accumulator empty, the bottom pressure on the column increases and the plates collect the liquid. When this happens the operator has no choice except to remove heat from the reboiler, allow the column to drain, pump the drainings back to the feed tank and start over. When startup occurs, heat must be applied slower than before. Some columns of this type can only be started with experienced operators and after columns are operating upsets may occur if vaporization rate in the reboiler changes. At present columns of 14, 18, and 24-inch tray spacing are popular.

Feed Temperatures—In discussing plate columns liquid and vapor velocities should be considered as a function of feed temperature. Three common feed conditions are: 1) all vapor, 2) liquid at the boiling point, and 3) cold liquid. Examples are given in Figure 7. Points to stress are with all vapor feed and no assumed heat losses liquid rate is the same above and below the feed plate. With cold liquid feed, vapor and liquid rates are both increased below the feed plate. Examples are shown so the operator can visualize what different feeds could do in a column and to point out that a preheater, or preheater and vaporizer, would relieve the load on the lower section of the column in Case III. Any number of feed conditions can exist but a comparison between others and the three shown can be obtained.

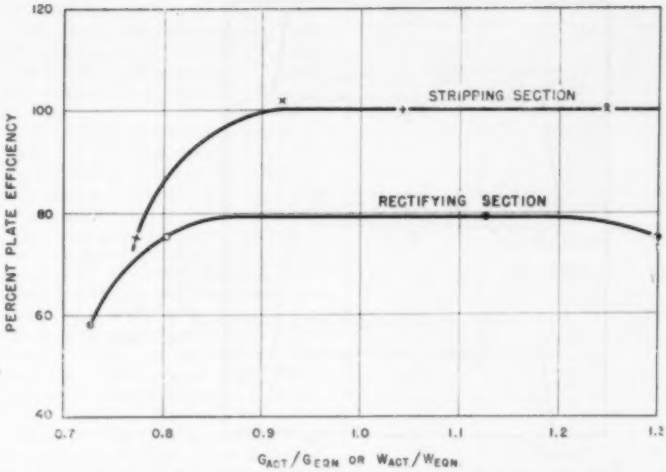

Figure 4. Over-all plate efficiency vs. vapor load. Solid dot, rectifying plates, 215 psia; Outline dot, rectifying plates, 265 psia; "x" stripping plates, 215 psia; and cross, stripping plates, 265 psia. See Reference 3.

Packed Distillation Columns

Packed columns are commonly used in industry. They are used as laboratory, pilot plant and plant units, and are suitable for installation where corrosive materials are being handled.

It is impossible to name the packings which have been used because almost every conceivable type has been experimented with. A few common packings are Raschig rings, Berl saddles, glass fibres, glass helices, wire gauze, etc. The first three are the most used in this country. Chemical resistant packings are usually ceramic with or without glazed surfaces.

Most towers are packed after they are in place. Packing methods are:

1) Dry addition, consisting of dumping in the top.
2) Dry addition using a bag with a rope on each end.
3) Wet addition using oil or water to fill the tower and adding packing at the top.

Of the methods mentioned No. 1 is suitable for short towers; in long towers breakage could be excessive. No. 2 is suitable for towers of reasonable diameter and is good from the standpoint of breakage, ease of filling, and contamination. No. 3 is suitable, but involves oils or water which may contaminate the packing and cause the job to be time consuming.

Baker and Harte[1] listed desirable packing characteristics as follows:

1) Low weight per unit volume.
2) Large surface per unit volume.
3) Large free cross section.
4) Small weight of liquid retained.

Other characteristics are:

1) Ability to withstand reasonable crushing forces.
2) Easily cleaned and ability to pass solids.
3) Ability to be used without special column preparation.

A large number of packings having some or all of the characteristics mentioned have been tried. Packings may be used fer entrainment removers, fractionation, absorption, extraction, etc. Packings chosen for distillation columns are supported by suitable grid work so they cannot be shaken

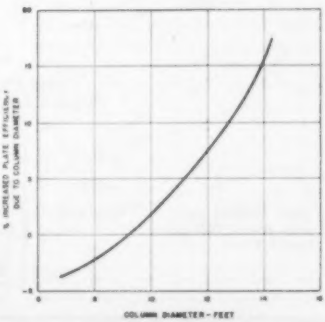

Figure 5. See Reference 4.

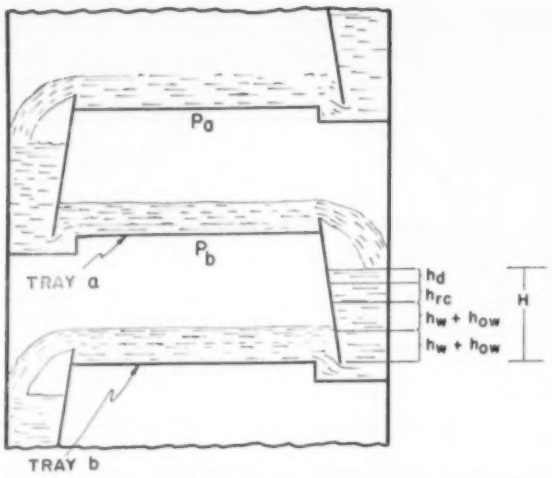

Figure 6. h_d = Pressure drop in downcomer. h_{rc} = Pressure drop in chimneys and caps. $h_w + h_{ow}$ = Weir height + liquid over the weir.

and broken. Before the column is operated the packing is usually settled by jarring and necessary additional packing is added.

Several rule of thumb methods are available as to the size of packed column to use and the size of packing to use. Baker, Chilton and Vernon[2] have concluded that in a tower more than eight times the packing diameter there is no tendency for liquid to channel or concentrate near the walls. Another rule of thumb is that packed distillation columns over 18 inches in diameter should not be used as they may give erratic results. Fenske[5] investigated effect of tower diameter on height equivalent to a theoretical plate (HETP) using ½-inch rings, and his results are presented in Figure 8. Fenske shows that for tower diameters below eight times the diameter of the packing (four inches in this case), the HETP is high, decreases to a minimum at four inches and then increases. Above 18 inches the results appear erratic and undependable. This type of curve appears to hold for various

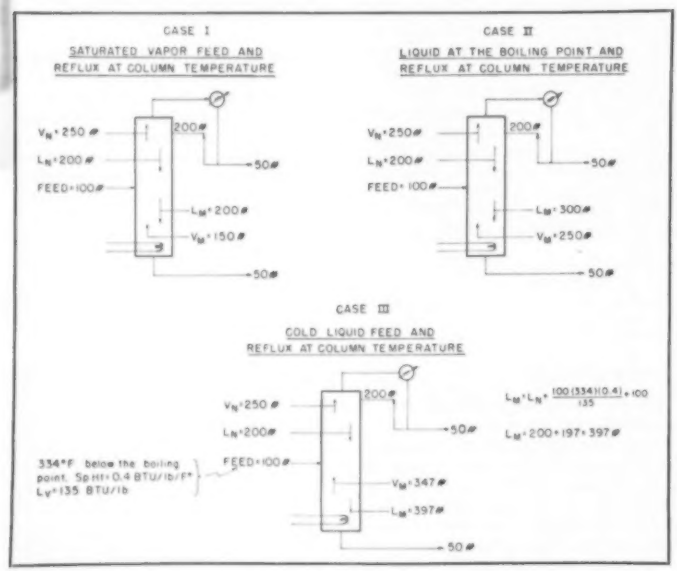

Figure 7.

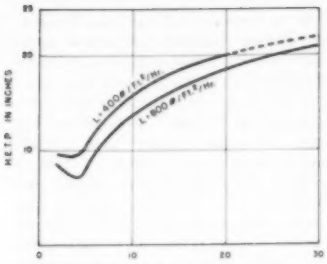

Figure 8. Data for ½-inch Raschig rings. See Reference 5.

ceramic packings and glass fibres. Herman and Kaiser[7] report 40 percent more height needed for a two-foot than a one-foot diameter column. Neureuther[8] reports a 36-inch column gave 22 to 24-inches HETP whereas 32 to 36-inches HETP values were obtained in a 50-inch diameter column. Precautions must be taken in large diameter packed columns for good liquid distribution, or inferior performance can be expected.

Packing shape has considerable effect on allowable rate of thruput. A recent method of presenting thruput and pressure drop data can be shown by reference to data of Schoenborn and Dougherty[11] on ½-inch Berl saddles and ½-inch Raschig rings. Figure 9 presents data for ½-inch saddles and rings at liquid velocities of 1010 and 980 pounds per square foot per hour respectively. Examination of the curves show lines of three slopes and two break points. The first break point is the loading point and the second the flooding point. As an example of thruput assume a G/ϕ value of 800 in both cases and note ½-inch rings show a pressure drop of 2.6 inches of water per foot of packing whereas ½-inch Berl saddles show a pressure drop of 1.0 inch of water. In the above, G is the mass velocity in pounds per square foot per hour and ϕ equals the square root of the value obtaned when the operating vapor density is divided by 0.075, the air density at standard conditions. Since pressure drop data correlates in this manner any change in column operating conditions, which lowers the vapor density, will decrease the value of ϕ and increase the G/ϕ value thus increasing the pressure drop through the column. Lowering the operating pressure on a packed tower will increase pressure drop across the tower if thruput is kept constant or will decrease thruput if pressure drop is constant. Berl saddles are more costly than Raschig rings but where large thruput with low pressure drop is needed they have a distinct advantage. Figures 10 and 11 are included to

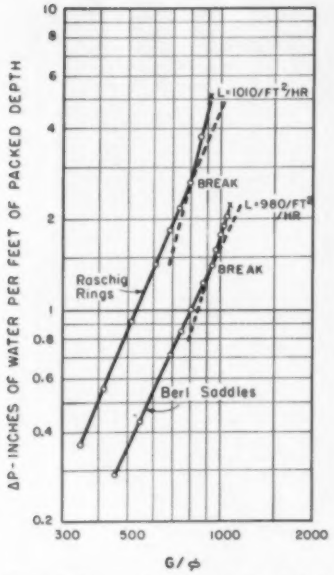

Figure 9. Pressure drop data on ½-inch Berl saddles and ½-inch Raschig rings for water (n = 1 csk) and air.[11]

further emphasize the pressure drop characteristics of Berl saddles and Raschig rings.

A rule of thumb method to remember on flooding velocities in packed columns is if the liquid viscosity in the column is about one centistoke, the column may flood at a pressure drop of 1.5 inches of water per foot. If the liquid viscosity is about 15 centistokes it may flood at a pressure drop of 1.0 inch water per foot. If the liquid viscosity is 30-40 Cst. it will flood at a pressure drop of 0.55 inch of water per foot. A second rule of thumb is the lower the viscosity of the liquid in the column the lower the pressure drop and the higher the flooding velocity.

Smoker[12] investigated vapor velocity and theoretical plates in a column at atmospheric and 200 mm. pressure. Benzene and ethylene dichloride were used as the test mixture and 5-8-inches diameter columns operating in parallel were used. Over-all column height was 46.25 feet and liquid redistributors were used every 9.25 feet. One-inch Berl saddles were used as packing.

TABLE 3
Maximum Efficiency Characteristics[11]

Condenser inlet pressure	1 atm.	200 mm Hg abs.
Thruput, eal./hr./sq. ft.	260	155
Thruput, gals./hr.	565	340
Theoretical plates	51	46
HETP, feet	0.91	1.01
Pressure drop, inches water/ft.	2.02	1.61
Pressure drop, inches water/plate	1.84	1.63
Pressure drop, mm Hg, ft.	3.78	3.1
Pressure drop, mm Hg./plate	3.4	3.1

The data are summarized in Table 3, and Figures 12 and 13. Examination verifies statements made regarding effect of vapor density on flooding velocity.

The column flooded at a liquid velocity of 155 gallons per hour per square foot at 200 mm Hg pressure. The curves verify the statement that at the same thruput the 200-mm column has a greater pressure drop than the atmospheric pressure column. The number of theoretical plates increase linearly as vapor and liquid rates are increased, the maximum occurring at the flooding point. Beyond the flooding point a sharp decrease occurs. The linear rise with thruput and pressure drop is in sharp contrast to data obtained on bubble plate columns where a range of thruput rates gave the same number of theoretical plates. A packed column gives maximum efficiency over a very narrow range whereas a bubble plate column has maximum efficiency over a wide range.

For a time it was felt packed columns could be operated with less pressure drop than bubble plate columns and still get the same number of theoretical plates but examination of the data of Table 1 will indicate that this may or may not be true. For example in the atmospheric column the pressure drop was 3.4 mm of Hg per theoretical plate compared to a bubble plate column which would be built to give 2.35 mm Hg pressure drop per actual plate. If the plate efficiency in the bubble plate column were 69 percent or above it would give equivalent or better performance than the packed column at the same pressure drop. The 200-mm column would give equal or better performance at efficiencies equal to or above 76 percent. Since a number of bubble plate columns give efficiencies in this range and higher, it would be well to examine pilot plant data closely before a decision is made on an installation where pressure drop is important.

Industrial experience has shown bubble plate columns are capable of handling liquids containing more solids than packed columns. In packed columns dirt and broken packing lodge in the packing and plug the column. Broken packing is often troublesome when polymerizable materials are handled because during shutdowns polymer forms in the pores of the packing and when the column is started monomer swells the polymer and breaks the packing.

Packed columns may be assembled in a short time at low cost but they should be operated in a narrow thruput range. Their low inventory makes control difficult. With the void space present in packed columns they drain readily and small changes in heat input allow the liquid to drain from

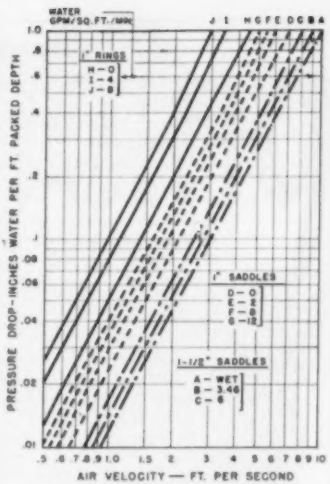

Figure 10. Pressure drop chart.

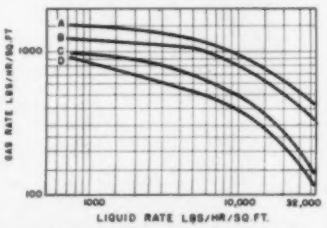

Figure 11. Loading velocities, air-water system. A: 1½-inch size Berl saddles; B: 1-inch Berl saddles; C: 1½-inch Raschig rings; D: 1-inch Raschig rings.

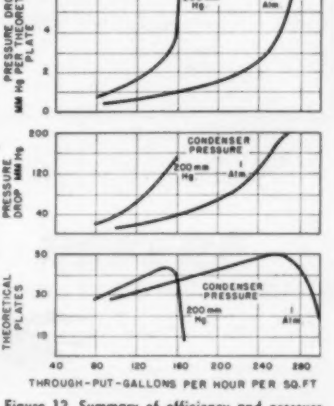

Figure 12. Summary of efficiency and pressure drop.[11]

NOMENCLATURE

A = component with lowest boiling point
Act. = Actual
B = component with boiling point higher than A
B.P. = boiling point
C = A variable constant in the Souders and Brown equation or a component in a mixture
Cst = Centistoke
d_v = Vapor density in lbs. per cubic foot
d_l = liquid density in lbs. per cubic foot
D = distillate rate lbs. per hour
Eqn. or Eq. = equation
GPM = gals. per minute
G or W = mass vapor velocity in lbs. per sq. ft. of column cross-sectional area per hour
H = liquid height in the downcomers
HETP = height of packing equivalent to a theoretical plate
L_M = lbs. per hour of liquid passing through the stripping section of the column
L_N = lbs. per hour of liquid passing through the rectifying section of the column
L_v = latent heat of vaporization in British thermal units per lb.
ΔP = pressure drop in inches of water per foot of packing
PPM = parts per million
W or G = mass vapor velocity in lbs. per sq. ft. of column cross-sectional area per hour
Weq. or Geq. = allowable mass vapor velocity in lbs. per sq. ft. of column cross-sectional area per hour calculated from the Souders and Brown equation.
X = mole % of component *A* in the liquid
Xc and Xp = compositions at the extremities of a theoretical plate
X_n, X_1, etc. = various concentrations
X_F = mole % of component *A* in the feed
X_D = mole % of component *A* in the distillate
X_W = mole % of component *A* in the residue
X_{still} = mole % of component *A* in the pot of a batch still
R or RR = L/D = reflux ratio
Rectifying Section = the section of column above the feed plate
Sp. Ht. = Specific heat in British thermal units per lb. per degree Fahrenheit
Stripping Section = the section of column below the feed plate
T = temperature
ΔT = temperature difference °C.
V_N = lbs. per hour of vapor passing through the rectifying section of the column
V_M = lbs. per hour of vapor passing through the stripping section of the column
y = mole % of component *A* in the vapor
$\phi = \sqrt{\frac{d_v}{0.075}}$ where 0.075 is air density in lbs. per cubic ft.
∞ = infinity
μ = viscosity
$\nearrow\!\!\!\!\rightarrow$ = adjustable line

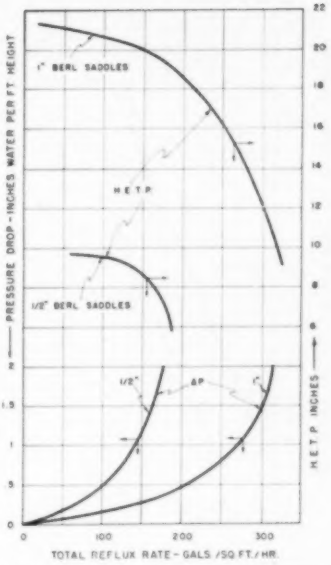

Figure 13. Indication of HETP values. Benzene-ethylene-dichloride system.[11]

the packing and dilute the bottoms product. If they are operated near the rate which gives maximum efficiency the liquid and vapor rates must be well controlled otherwise the column will flood.

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* * *

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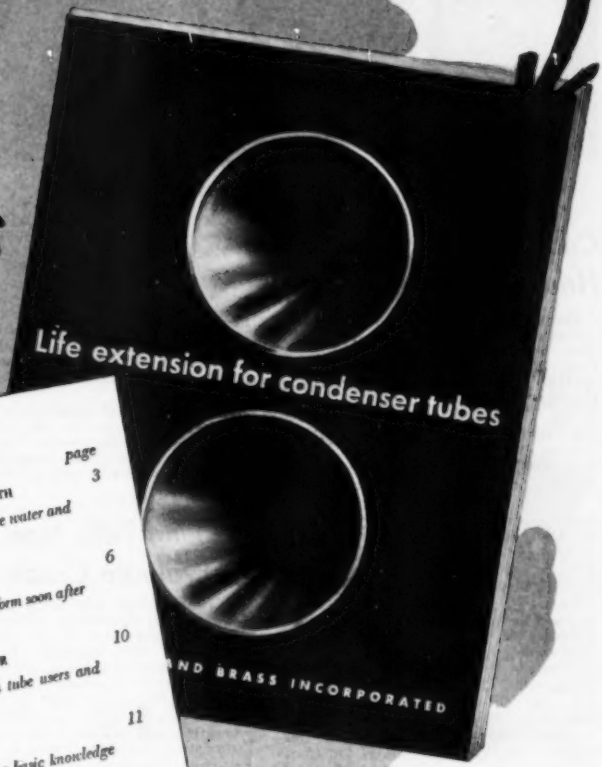

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PREVENTIVE METALLURGY TO MAINTAIN TUBE HEALTH 3
The life span of a condenser tube depends upon the water and operating conditions and the alloy selected.

PROTECTIVE FILMS ARREST CORROSION 6
Life expectancy is prolonged if protective films form soon after service begins.

REVERE MINUTE MEN IN CONDENSER TUBE WAR 10
"Trouble shooters" serve as liaison between tube users and Revere Research Laboratory.

DEVELOPMENT WORK IN TUBE ALLOYS 11
Experiment in Revere laboratories develops basic knowledge of tube performance under variable conditions.

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Who's Writing for *Petroleum Refiner*

Leon T. Mart | Donald Baker | Melvin Nord | L. C. Werking | J. B. Stripling

Cooling Tower Topic Handled by Veterans

Donald F. Baker, who has been in the engineering research department of The Marley Company, Inc., Kansas City, Mo., since 1942, is a member of ASME, ASME Committee for Revising Cooling Tower Test Codes and of the Wood Deterioration Committee, Cooling Tower Institute.

Leon T. Mart, who is president of The Marley Company, is a member of ASME, ASRE and ASH&VE.

After joining at least six technical organizations between them, in this issue of PR the two men join each other to produce "Analyze Cooling Tower Performance by This Method," which begins on page 97.

Both Mart, who has devoted the major part of the last 25 years of his activities to the development of industrial cooling, and Baker, who has been associated with air conditioning and refrigeration as an engineer, bring into the joint effort a background rich in experience with cooling towers.

Baker, who at one time was connected with the Cities Service Oil Company in its production department, established and operated a test plant for The Marley Company in which all types of cooling towers and equipment were studied and developed.

Mart, author of many books and papers relating to his engineering specialty, has sponsored and directed continuing research in all phases of water cooling and has been very active in establishing codes and methods for testing performances of towers. He also played a part in organizing the Cooling Tower Institute, of which he has been an officer since its inception.

Melvin Nord Tackles Impure Water Problem

"Water Pollution—Get Ready To Tackle It," which begins on page 125, is the product of Melvin Nord, associate professor of Chemical Engineering at Wayne University, Detroit. An active member of several technical organizations including AIChE, and author of more than 40 technical and legal papers, he has done consulting work in patents, process design and equipment design.

But reading, writing and teaching is not all he has done. His practical experience in the industry amounts to six years, and a part of it was spent working on gaseous diffusion plant design for atomic energy.

Another item will be added to his list of accomplishments this fall, when his "Textbook of Engineering Materials" will be published. At present he is working on a book of legal problems for engineers.

Stripling Tells How To Evaluate Crudes

J. B. Stripling, who is in charge of the analytical distillation section of the technical department at the Beaumont refinery of the Magnolia Petroleum Company, has long been interested in the evaluation of crude oils. This interest usually reveals itself in his writings. Previously he collaborated on "Evaluation of Coastal Type Crudes for Lubricating Oils," and now in "Crude Evaluation—Here Is An Improved Method," which begins on page 137, he discusses his interest further.

Married and the father of a nine-year-old daughter, Francis, the onetime University of Texas student allots his spare time to his shop of wood and metal working tools.

Thomas Wins Award From ASTM for Service

Ray Thomas, author of "Thermal Insulation for Industrial Requirements," Part VII of which appears on page 115, recently received an Award of Merit from the American Society for Testing Materials in recognition of distinguished service.

Thomas, staff engineer, carbide and carbon chemicals division, Union Carbide and Carbon Corporation, was given the award for inspiring leadership in standards and research work, notably in committee in thermal insulation materials.

Beating Corrosion Is Werking's Topic

Leroy C. Werking, author of "Cathodic Protection Licks Corrosion," the interesting article on page 122, was born in Watertown, Conn. After graduating from Transylvania College, Lexington, Ky.—B. S. Cum Laude—he continued his studies at the University of Kentucky.

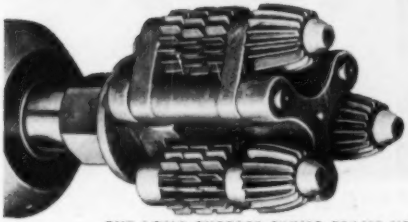
The majority of his professional experience has been gained through Union Carbide and Carbon Corporation and, since 1930, its division, National Carbon Company. He became manager of the industrial carbon department in 1944 and still holds that position. Since 1930 his major activities have been in the development, specification and application of carbon products in new industrial uses.

He is married and holds membership with the Electrochemical Society and AIChE.

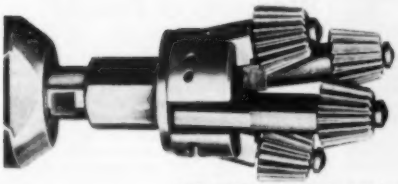
Georgia Group Does Packed Columns Study

Two Georgia Tech professors, a candidate for a Ph.D degree and an ex-Tech student got together, and in the best school tradition turned out the top-notch engineering piece on page 141, "Effect of Surface Tension on Flooding Packed Columns." Senior collaborator on this piece of technical journalism was none other than the dean of Tech's engineering school, Jesse W. Mason. Whatever time he had left after supervising the architecture, drawing and mechanics schools at Tech, he devoted to the production of the article. Mason has many years of practical and academic experience, including work with the Girdler Corporation, the Palmer Asbestos and Rubber Corporation and the Connecticut State Water Commission behind him. In 1935, he became assistant professor of chemical engineering at the University of Florida, moving to Georgia Institute of Technology in 1938. In 1941, he became head of the chemical engineering department, a position he held

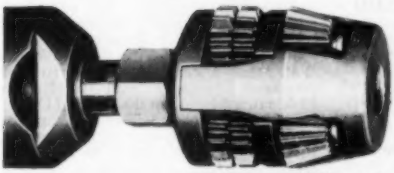
These LAGONDA *heads can lick any coke problem*



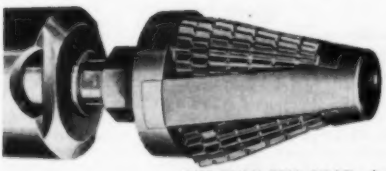
THE LONG-SURFACE SWING-FRAME HEAD with plenty of expansion for tubes of wide tolerance.



THE TYPE H-2 HEAD, particularly good on uneven coke deposits.



THE TYPE UO HEAD, most widely used for its adaptability to average coke conditions.



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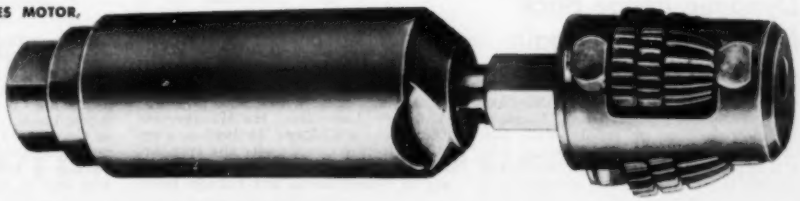

Y-307

[Who's Writing for *Petroleum Refiner*]

W. M. Newton

C. O. Summers

Jesse W. Mason

Brooks Metcalfe

D. F. Tver

until becoming dean in 1948. He is married and has one son.

Brooks Metcalfe is the Ph.D candidate of the team. He is a Texan, receiving his B.S. and M.S. from the University of Texas' chemical engineering department, before moving on to Tech to secure his third sheepskin. His practical experience includes two and a half years with Dow Chemical Company at Freeport, Texas, two years as an engineering officer in the Navy, and two years with the Bureau of Industrial Chemistry at the University of Texas. He was also employed at the State Engineering Experiment Station at Georgia Tech for a year and now holds a fellowship from the Research Committee of the Institute.

The ex-student member of this writing team is Charles Orlando Summers, who received his B.S. in chemical engineering from Tech in 1949, and is now employed by the Institute plant of the Carbide and Carbon Chemical Division of the Institute. A native Georgian, Summers enrolled in graduate school at Tech after receiving his first degree, and in 1951, was conferred a M.S. degree. His experience includes two years as an officer in the Army's Corps of Engineers. Summers, his wife and young son, now reside in Charleston, W. Va.

William Meese Newton is the fourth and final co-author and is currently affiliated with Georgia Tech as professor of chemical engineering. Newton is another Texan, born in Dallas, but receiving his B.S., M.S. and Ph.D. degrees from the University of Iowa. He has served as chemical engineer for the Tennessee Valley Authority and for the Union Oil Company of California, and as associate professor at the University of Texas. Newton likes to grass farm, raise Tennessee Walking horses and Chow dogs in his off time.

Dynamic Benge Back In PR Columns Again

If anyone has any doubts about the importance of employe morale and the importance of checking on it, then Eugene J. Benge's "Measuring Employe Morale" on page 69 should make him think again. The dynamic Benge, who last appeared in PR in April, has found himself more and more in demand as a lecturer as management becomes aware of his precepts. In addition to his speaking and writing activities, he is president of Benge Associates, Hu-Management Engineers, of Chicago. In 1943 as a result of lecture tours under the sponsorship of Temple University, the University of Pennsylvania and Babson Institute, he started his own clinics for sales managers.

Benge took his degree in public education and studied at the U. S. Army psychological training school in 1918 and worked as a fellow in personnel research at Carnegie Tech. He is the author of numerous guidance and text books and belongs to various societies. He and his wife live in Asheville, N. C.

Irving Granet

Philip Kass

Granet and Kass Team On Similar Interest

Irving Granet and Philip Kass, joint authors of "The Viscosity, Thermal Conductivity and Specific Heat of Dry Air At Elevated Pressures and Temperatures," which starts on page 113, are alike in many respects. Both received B.M.E. degrees at Cooper Union, both did graduate study at Brooklyn Polytechnic Institute, both belong to ASME, both are employed by Foster Wheeler Corporation, and both are married.

But the similarities in their lives stop when it comes to hobbies, choices of residences and choices of services during the last war.

Granet, a design engineer on a U. S. Navy torpedo project before joining Foster Wheeler, fills his spare time with model ship and automobile making and reading detective stories. He spent two years in the U. S. Air Corps and makes his home in Brooklyn.

Philip Kass, who takes pride in his three children, lists his hobbies as bridge and golf. He spent two years in the U. S. Navy and at present he lives in Westfield, N. J.

Similarities and differences are a good combination in the writing of any article.

Writer Works on Workings of People

Understanding people and helping them to understand themselves and the things around them can be a fascinating and worthwhile career. One person who carried this idea a step further by making such activities a successful career is David F. Tver, author of "Wages and Salaries—How To Administer Them," the provocative and timely article beginning on page 104.

Tver launched his "understanding" career when he graduated with a B.S and M.S. in clinical and industrial psychology. Supplemented by additional training in industrial engineering, his education led him to three and one-half years in military service during World War II as a clinical psychologist and personnel consultant with the Neuro-Psychiatric Section of the Medical Corps.

Later as a civilian he did some private consulting and then went with Anderson-Prichard Oil Corporation as industrial relations director, a position he has held for the past six years.

That time which isn't taken up by his work and his hobbies, which include golf, bowling, tennis and hunting, is filled by activities in organizations. He is president of the Oklahoma City Personnel Association; chairman of the industrial relations committee, Oil and Gas Division of the Oklahoma Chamber of Commerce; and chairman of the Chamber's Personnel Advisory Committee.

As though work, hobbies and activities in organizations are not enough to fill his hours, the one-time instructor occasionally gives lectures on various industrial relations subjects. Somehow or another, during the process of his many projects, Tver finds time to write. And his efforts have paid off. He has had several articles published in industrial relations and personnel magazines.

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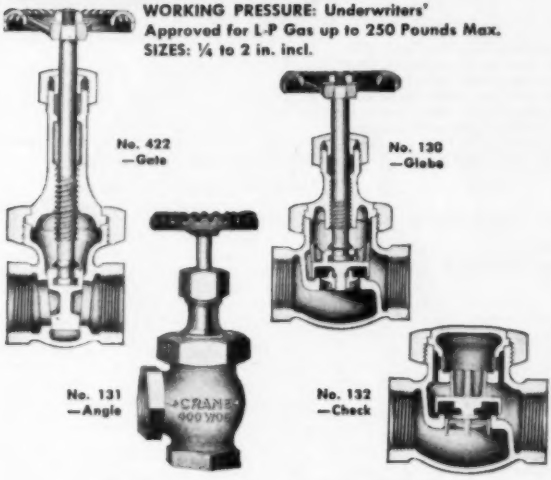

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What's Happening in the Industry

Pan American's Third Step

An architect's sketch shows a view of the new combination research laboratory and office building for which ground was recently broken at Pan American Refining Corporation's Texas City, Texas refinery. To be air conditioned and fitted with modern equipment, the building is a part of the enlargement of the company's research and development facilities, which also includes the construction of a high pressure laboratory building. This enlargement is the third step in an expansion program that got under way at the dedication of the Baltimore automotive laboratory in 1947. The next step came with the completion of a new process laboratory in 1950. Completion and occupation of the newest facilities is expected in a little more than a year.

Record Breaking Attendance Seen Probable For American Petroleum Institute Sessions

With a record breaking attendance expected, preparations are nearing completion for the 32nd annual meeting of the American Petroleum Institute to be held November 10 to 13, inclusive, in the veteran host city of Chicago.

The Institute's annual meeting usually draws to its sessions more than 5000 oil and gas men, industrialists, technicians, business leaders and military and government representatives. Last year's attendance of 5648 registrants was an all-time high. But because of the gathering's growth in size and in stature with each passing year, it would not be out of line for 1952 attendance to set another registration peak.

Conrad Hilton Hotel will serve as convention headquarters and all sessions except those of the Division of Transportation will be held in the Hilton. The Transportation sessions will be held in the Palmer House.

Principal speakers for the two general sessions to be held on the mornings of November 12 and 13 include Secretary of the Interior Oscar L. Chapman, who also serves as Petroleum Administrator for Defense; Frank M. Porter, president of the Institute; Oveta Culp Hobby, co-publisher of the *Houston Post*, Houston; U. S. Senator William Knowland of California; and T. S. Petersen, president of Standard Oil Company of California.

L. S. Wescoat, president of The Pure Oil Company, Chicago, and chairman of the API Board of Directors, will preside at the two general sessions.

The API Board of Directors will meet all day Tuesday, November 11, and on the afternoon of Wednesday, November 12.

The Group Session, Division of Refining, will be held on November 10 with W. L. Stewart, Jr., Union Oil Company of California, presiding. This meeting will include a report of the division's nominating commttee, an election of members of the general committee of the Division of Refining and a discussion by John E. Swearingen and John W. Boatwright, Standard Oil Company (Indiana) of the future availability of petroleum and the ability of the industry to meet the requirements.

Other sessions include:

Friday, November 7—Division of Refining. Manufacturers Subcommittee On Safety and Relief Valves, L. P. Stillman. Joint meeting (all day): Subcommittee on Low-Pressure Storage Tanks, W. L. Bowler. Manufacturers Subcommittee on Low-Pressure Storage Tanks, H. C. Boardman. Manufacturers Subcommittee on Refinery Valves, W. P. Kliment.

Sunday, November 9—Committee on Petroleum Products, A. E. Miller. Joint Meeting: Subcommittee on Mechanical Equipment, E. F. Voss. Manufacturers Subcommittee on Centrifugal Pumps, Lynn Sawyer.

Monday, November 10—Division of Refining. Subcommittee on Corrosion, E. Q. Camp. Program Committee, Division of Refining, W. M. Holaday. Subcommittee on Unfired Pressure Vessels, N. J. Rees. Subcommittee on Electrical Equipment, L. M. Goldsmith. Advisory Committee, Division of Refining, M. Halpern. Nominating Committee, Division of Refining, W. J. Sweeney.

Group Session, Fundamental Research. Research on Composition and Properties of Petroleum, Howard G. Vesper, California Research Corporation: Robert E. Wilson, S. S. Shaffer, Harry Sutherland, W. E. Huhn, W. G. Lovell, W. D. Seyfried and R. R. Brattain.

Group Session, Symposium of Evaporation Loss. Evaporation Loss of Petroleum from Storage Tanks: "A Review of the Basic Theory and Mechanism and an Outline of the Practical Problem," "Losses from Cone-Roof Tanks" and "Evaporation from Conservation-Type Tanks—A Practical Review."

Tuesday, November 11—Group Session, Financial and Accounting. Financial and Accounting Session, R. A. Martin, The Standard Oil Company (Ohio): "The Outlook for Business." Marcus Nadler, professor of Finance, New York University; "Petroleum and the American Way of Life," A. A. Stambaugh, The Standard Oil Company (Ohio).

Committee on Refinery Equipment, W. H. Creel, National Committee on Smoke and Fumes, W. L. Stewart, Jr. General Committee, Division of Refining, W. L. Stewart, Jr. Subcommittee on Electrical Equipment, L. M. Goldsmith.

Group Session, Financial and Accounting Session, R. A. Martin: "The Financial Executive in Modern Management." T. F. Bradshaw; "Trends in Employe Benefits and Incentives." W. B. Dunckel.

Wednesday, November 12—General Session, L. S. Wescoat, Frank M. Porter, president, American Petroleum Institute; Hon. Oscar L. Chapman.

Group Session, Lubrication Session. Address, W. B. Perriguey, Esso Standard Oil Company; "Let The Customer Vote," Donald C. O'Hara, National Petroleum Association; "The New API System of Service Classification and Designations for Motor Oils—How We Can Make It a Success." G. A. Round, Socony-Vacuum Oil Company, Inc.; "Selling is Everybody's Business." H. G. Moock, formerly vice president of Plymouth Division, Chrysler Corporation.

Thursday, November 13—General Session, L. S. Wescoat. Address, Oveta Culp Hobby and Address, Hon. William F. Knowland.

Reprint Gem Coming Up!

Because of the unprecedent demand for 1) the Process Section and 2) the Sittig article "Catalytic Cracking Techniques in Review," features of our September issue, PETROLEUM REFINER is planning to reprint both under a single cover.

This reprint, which will be in two colors and include something like 150 pages, will be sold at the rate of $1 for the single volume.

One company has ordered 1000 copies of the Sittig article so that each of its employes may have a copy. Another has ordered 400 copies, one for each technical employe.

Send remittance with order to Reprint Department, PETROLEUM REFINER, Box 2608, Houston 1, Texas.

Hydrocarbon and Edeleanu Join in Frankfurt Venture

Hydrocarbon Research, Inc., of New York has announced the establishment of a cooperative undertaking with Edeleanu Gesellschaft, M.B.H. of Frankfurt, Germany, whereby solvent refining plants incorporating the latest process developments of Edeleanu and Hydrocarbon will be offered to petroleum refiners.

Emphasis will be placed on the design of plants for the production of paraffinic feed stocks for catalytic cracking, and of high quality burning oils and fuels.

Tax Write-Offs Little Affected By Plant Dispersal Plan

While the Defense Production Administration is putting growing emphasis on plant dispersals as a national security measure, it has reported that no petroleum plant application for rapid tax write-off has been rejected because of failure to comply.

A member of DPA pointed out that small projects—below $1 million—and pipe line projects were not required to meet dispersal standards, and that because most new petroleum facilities were plant expansion rather than entirely new projects, dispersal could not be considered as a major factor. It was emphasized, however, that companies making

The Mark of Sound Refinery Engineering

THIS is the mark of McKee engineering. To oil men all over the world it means sound process and plant design, thorough, efficient engineering and construction. It is backed by an organization with the integrity and experience, the scope and resources to undertake your refinery project and fulfill the promise that *McKee Engineering means assured results.*

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

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District Engineering Offices: Union, New Jersey and Tulsa, Oklahoma.

application for tax write-off benefits should fill out required Appendix B form, relating to dispersal, else their applications might be delayed until the information is obtained.

Case Institute Sessions To Discuss Pollution Control

A three-day symposium on atmospheric pollution control for the chemical industry will be held from November 10-12, 1952, on the campus of Case Institute of Technology in Cleveland under the sponsorship of the department of chemical engineering. The registration fee has been set at $25 for the session which will include a banquet.

J. E. Dyer Named to Board

James E. Dyer, vice president and director of marketing of Sinclair Refining Company and vice president of Sinclair Oil Corporation, has been elected to the board of directors of Sinclair Oil. He fills the vacancy left by the death of Sheldon Clark.

COVER UP—The Delayed Coking diagram below should have appeared at the top of page 149 in the September Process Issue instead of the one printed. Readers are asked to paste this diagram over the erroneous one in their copy. The related text on the opposite page in the Process Issue is correct.

Petrochemicals Output Doubling Seen by Egloff

Petrochemicals production will be doubled in the next ten years, Dr. Gustav Egloff, Universal Oil Products Company, recently predicted at the National Chemical exposition.

Dr. Egloff said that the "petroleum industry will have an even greater impact on the chemical industry in the future than it has had in the past. At present, 25 percent of the entire chemical production is petrochemicals, and estimates show that 50 percent will be petrochemicals in 1962."

Boultbee to Replace Yabroff As Manager of Shell Research

Arthur H. Boultbee has been appointed manager of manufacturing research for Shell Oil Company, replacing D. L. Yabroff, who is returning to Shell Development's research laboratory at Emeryville, Calif.

Born in Kenora, Ont., Can., Dr. Boultbee obtained his Ph.D. in chemical engineering from the University of Toronto. He joined Shell Oil Company as a chemist in 1935.

Mount Becomes Manager Of Socony-Vacuum Aviation

Wilbur S. Mount, manager of product engineering in Socony-Vacuum Oil Company's gasoline and fuel oil department, will become manager of the aviation department in September, replacing Warren L. Baker, retired.

Refinery Expansion Is Reportedly Exceeding 1951

Capital outlay by refineries this year is likely to be at least 30 percent above 1951, the Commerce Department's Office of Business Economics said recently. The Bureau said that the over-all average for manufacturing companies would be about 15 percent above last year and that such industries as metals, rubber, petroleum refining and iron and steel would lead the way with increases of over 30 percent.

Dr. K. A. Smith Promoted To Sinclair Division Director

Sinclair Research Laboratories, Inc., recently announced the promotion of Dr. K. A. Smith to the post of director of the light oils division.

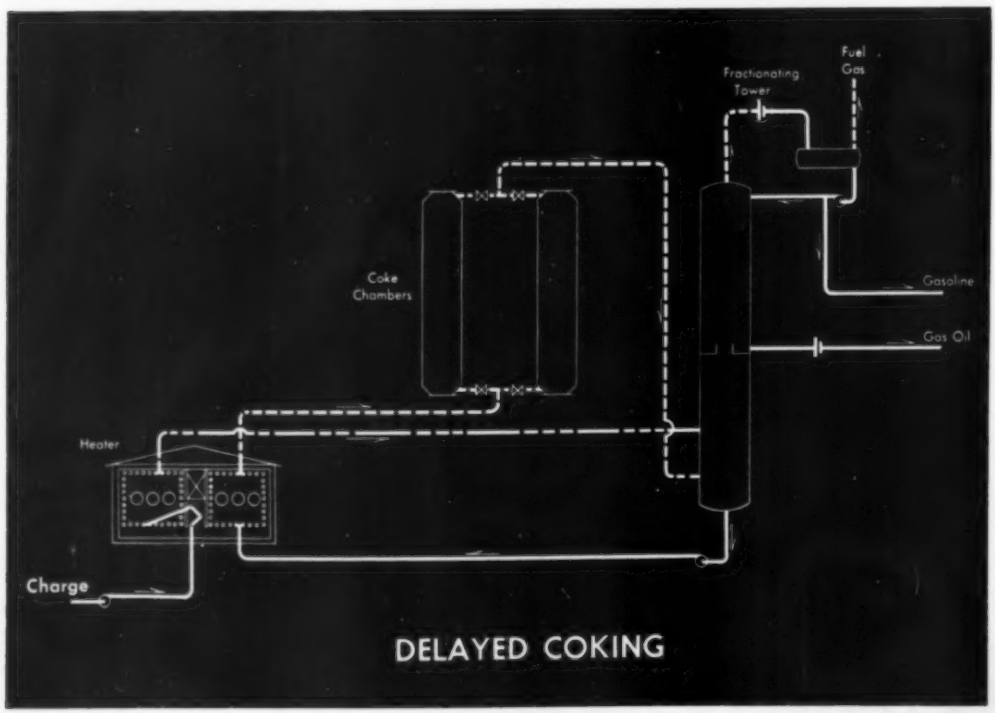
Dr. Smith began his career with Sinclair in the research and development department in 1943, when he was graduated from the University of Wisconsin with a B. S. in chemical engineering. In 1948, he was awarded his Ph.D in chemical engineering from the same school.

Dr. Smith holds membership in several scientific organizations including A.I.Ch.E.

Henry Dawes Dies

Henry M. Dawes, since 1947 executive committee chairman of the Pure Oil Company of which he was president from 1924 to 1947, died recently in a hospital in Evanston, Ill. His age was 75.

Brother of the late General Charles G. Dawes, former vice president of the U. S., Dawes was also a director of the American Petroleum Institute.



BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND. — IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

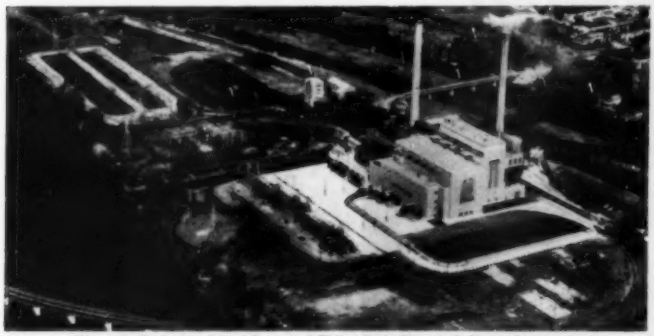


Figure 1. Barbadoes Island Station of Philadelphia Electric & Power Company.

Barbadoes Island Power Output Increased 275%

Generating enough power to supply the electrical needs of more than 500,000 families, the recently expanded Barbadoes Station of the Philadelphia Electric & Power Company is an outstanding example of a modern, efficient power plant.

Located on historic Barbadoes Island in the Schuylkill River between Norristown and Bridgeport, Pennsylvania, the station originally had a capacity of 48,000 KW. In 1949, two new turbo-generators were placed in service, each with an effective rating of 66,000 KW. The present capacity of the four operating units is 180,000 KW, which is used to supply the northwestern portion of Philadelphia Electric's territory.

Unit Arrangement for Reliable Performance

For the operation of the installations, a modified unit arrangement was adopted for simplicity and reliability. The turbo-generators, feedwater systems, main steam systems, draft and dust collector systems are kept separate, thus preventing any possible difficulty in one unit from affecting the operation of the other. The principal diversions from the unit arrangement are circulating water tunnels, cooling water system, stack and an auxiliary steam system.

Efficient Use of Bleed Steam

The heat balance diagram for one of the two identical units is shown in Figure 2. The economical use of bleed steam for producing feedwater temperatures suitable for the boiler design is apparent in this diagram.

Both main condensers are radial flow, two-pass, non-divided water-box type with 37,500 square feet of effective surface. Each condenses 375,000 pounds of steam per hour at 1 inch Hg. absolute pressure when supplied with 40,000 gpm cooling water at 50° F.

There are a total of 7,450 Admiralty tubes in the condenser. These tubes are 18BWG, ⅞ inch in diameter, with a wall thickness of .049 inches. The expected life of the tubes is from 15 to 20 years, based on the previous performance of other tubes of the same alloy with Schuylkill River water.

The air ejector for each unit is equipped with two banks of two-stage ejectors mounted on an inter and after condenser. They are designed for use with 400 psig motive steam to remove 8 cfm of free air and associated water vapor at 70° F. The drain coolers are horizontal, two-pass units, each designed to heat 555,000 pounds of concentrate an hour.

All five feedwater heaters, in each system, are of the vertical, channel end up, four-pass, straight condensing type, designed to handle the same amount of concentrate per hour as the drain cooler. The operating water pressure through the tubes is 600 psig, although they are capable of handling 725 psig. The table in Figure 3 shows the number, dimensions and alloy of the tubes used in each of the heaters.

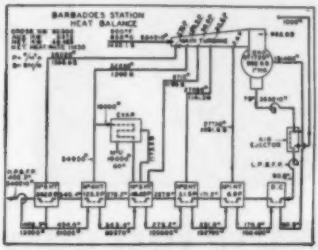


Figure 2. Heat balance diagram of one of the two identical units recently installed at Barbadoes Station.

Bridgeport Corrosion Laboratory

Changing operating conditions, new designs in equipment, and improvements in efficiency of power production call for alloys with special properties. Bridgeport's Corrosion Laboratory will be glad to work with designers, builders, and operators of power plants to help select the copper-base alloys which will give the most dependable service. Contact the nearest Bridgeport branch office for your condenser and heat exchanger tube requirements.

(8759)

ITEM	NO. OF TUBES	SIZE (dia.)	GAGE	LENGTH	ALLOY
Drain Cooler	460	⅝"	16	216"	Admiralty
#1 Heater	798	⅝"	16	180"	Admiralty
#2 Heater	820	⅝"	16	162"	Admiralty
#3 Heater	820	⅝"	16	156"	Admiralty
#4 Heater	820	⅝"	16	174"	Admiralty
#5 Heater	820	⅝"	18	199"	70-30 Cupro-Nickel

Figure 3. Sizes and alloys of condenser tubing used in drain coolers and feedwater heaters.

Announcing the NEW

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Spiral Reamer

1/8" to 2"
RIDGID SPIRAL REAMER 2-S
RIDGID also makes No. 2 extra-long-taper pipe reamer — reams only burr, won't harm pipe or conduit.

NOW fast easy reaming with the new RIDGID 2-S Spiral

- ★ Reams pipe fast, easily and cleanly.
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- ★ Typical RIDGID tested design, fine craftsmanship and materials—extra long service for your money.
- ★ Buy the new 2-S spiral at your Supply House.

Reamer unit sold separately—fits your RIDGID OOR threader handle

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[What's Happening]

OIIC Predicts Big Things For Fifth Oil Progress Week

Indications are that the fifth annual observance of Oil Progress Week will be the biggest and most noteworthy of the series to date, according to the Oil

WHO'S MEETING WHERE

OCT.	
12–18	Oil Progress Week.
13–15	Texas Mid-Continent Oil and Gas Association, Thirty-Third Annual Meeting, Hotel Texas, Ft. Worth, Texas.
16–17	Western Petroleum Refiners Asso., Regional Meeting, Garrett Hotel, El Dorado, Ark.
19	National Gasoline Association of America, Southern Regional Meeting, The Blackstone Hotel, Tyler, Texas.
20–24	National Safety Council, National Safety Congress and Exposition, Chicago, Conrad Hilton Hotel.
20–21	Independent Petroleum Asso. of America, Annual Meeting, Mayo Hotel, Tulsa, Okla.
20–22	American Oil Chemists' Society (Fall Meeting), Netherland Plaza, Cincinnati.
20–24	National Safety Council (40th National Safety Congress and Exposition), Conrad Hilton Hotel, Chicago.
22	Oklahoma Utilities Association, Electric Light and Power Division, Western District, Lawton, Okla.
23–24	American Inst. of Mining and Metallurgical Engineers (Petroleum Branch—West Coast Fall Meeting), Statler Hotel, Los Angeles.
23–24	Independent Petroleum Assn. of America, (Annual Meeting), The Skirvin, Oklahoma City, Okla.
24	Oklahoma Utilities Association, Electric Light and Power Division, Eastern District, Lawton, Okla.
24	Natural Gasoline Association of America, Regional, Blackstone Hotel, Tyler, Texas.
Wk. of Oct. 27	AGA Annual, Atlantic City, Auditorium.
27–30	American Petroleum Institute (Division of Refining, Committee on Analytical Research,) The Rice, Houston.
30–31	Society of Automotive Engineers (National Diesel Engine Meeting), Chase Hotel, St. Louis, Mo.
30 to Nov. 1	Rocky Mountain Oil and Gas Assn. (Annual Meeting), Cosmopolitan Hotel, Denver, Colo.
NOV.	
6– 7	Society of Automotive Engineers (National Fuels and Lubricants Meeting), Mayo Hotel, Tulsa, Okla.
8–13	Oil Industry Information Committee, Conrad Hilton Hotel, Chicago.
10–13	API Annual, Chicago, Conrad Hilton Hotel and Palmer House.
17–18	Oil Industry TBA Group (Annual Meeting), The Park Plaza and Chase Hotels, St. Louis, Mo.
20–21	Western Region of the National Assn. of Corrosion Engineers (Second Annual Conference), Biltmore Hotel, Los Angeles.
30 to Dec. 5	American Society of Mechanical Engineers (Annual Meeting), Hotel Statler, New York.
DEC.	
1– 3	New Mexico Oil and Gas Assn. (Annual Meeting), Alvarado Hotel, Albuquerque, N. M.
1– 6	20th National Expoaition of Power and Mechanical Engineering, Grand Central Palace, New York.
7	Natural Gasoline Asso. of America, Panhandle-Plains Regional Meeting, Herring Hotel, Amarillo, Texas.
7–10	AIChE, Annual, Cleveland, Hotels Cleveland and Carter.
9	National Petroleum Council (Fourth Quarterly Meeting), Department Auditorium, Washington, D.C.

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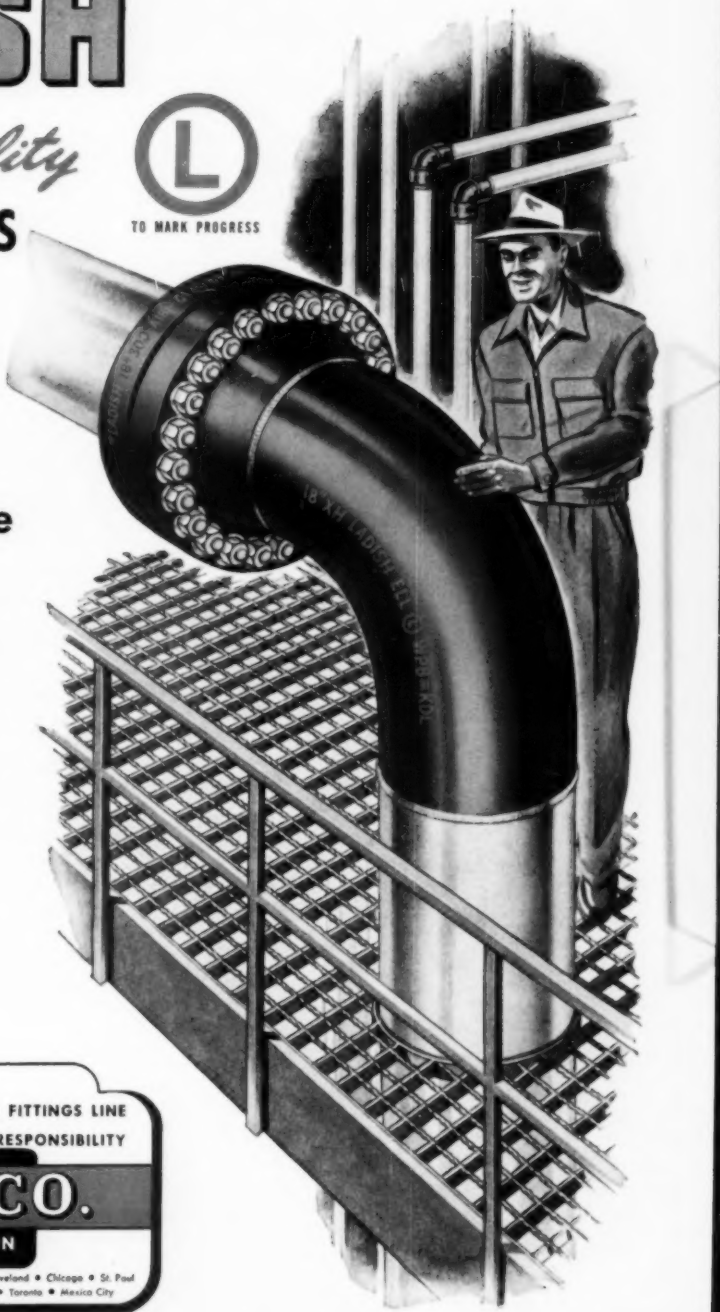

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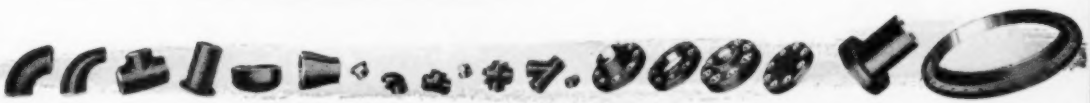

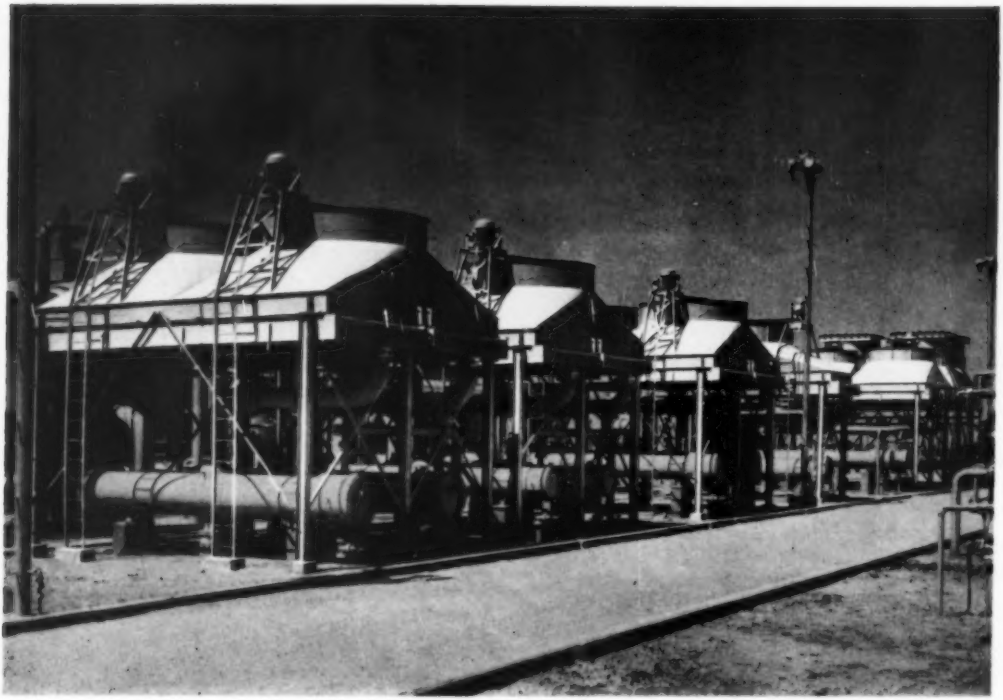

HUDSON *Solo-aire* EXCHANGERS

Bulletins on HUDSON TOP PERFORMANCE cooling equipment mailed upon request.

At the Diamond M-Sharon Ridge gas processing plant in Scurry County, West Texas, most of the heat from gas compressed in three stages is dissipated directly to the air in the SOLO-AIRE units shown above. Other SOLO-AIRE units are employed in this plant for oil cooling, acid gas condensing, still overhead condensing, propane and butane condensing, and jacket water cooling. In this and many other plants in water-scarce West Texas, Hudson SOLO-AIRE units have established their reputation for dependable, trouble-free operation.

HUDSON
ENGINEERING CORPORATION
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Industry Information Committee, American Petroleum Institute, which sponsors the event.

During the seven-day period Oil Progress Week will be observed (October 12-18), great numbers of oil men will make first-hand reports to their local communities or participate in luncheon and dinner meetings, rallies, parades, radio and television shows and many other special events.

The "2=3" theme will be talked about throughout America during the week, OIIC officials believe. This cryptic phrase pinpoints the progress that has been made in gasoline quality alone since 1925. It symbolizes that two gallons of today's gasoline provides the same amount of work-energy as three gallons did 25 years ago.

OIIC Elects Officers; S. K. Smith Named Chairman

Stanton K. Smith, president of Smith Oil & Refining Company, has been elected national chairman of the Oil Industry Information Committee, American Petroleum Institute, succeeding Charles Z. Hardwick, vice president of The Ohio Oil Company.

Smith

Smith was elected to the chairmanship at a meeting of the Committee in Chicago, and will take office on January 1, 1953.

Philip C. Humphrey, manager of public relations, The Texas Company, New York, and William N. Finnegan, Jr., assistant to the president, Humble Oil & Refining Company, Houston, were re-elected vice chairmen.

Two new vice chairmen named were W. J. Loufman, president of Fleet Wing Corporation, Cleveland, Ohio, and C. Haines Finnell, director of public relations and advertising, Union Oil Company of California, Los Angeles.

John S. Cooke of Hoboken, N. J. was re-elected secretary for the sixth consecutive year.

Nelson Becomes President Of Lake Superior Refining

Announcement was recently made of the election of Edwin F. Nelson as president and general manager of the Lake Superior Refining Company, Superior, Wisconsin. The board of directors meeting at which Nelson was elected also re-elected H. J. Underhill, vice president, R. A. Crawford, secretary, and Leslie Olsen, treasurer.

For many years Nelson has taken an active part in the problems of petroleum refining, particularly relating to the development and application of refining processes for the production of improved quality products. His knowledge should prove beneficial in the management and operation of the refinery.

Standard (Indiana) Appoints A. A. Harban as Group Leader

A. A. Harban has been appointed group leader in the chemical products division at the Whiting, Ind., research

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PABCO
PRECISION MOLDED
UNIFORMITY
85% MAGNESIA HEAT INSULATION
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PRECISION MOLDED
INSULATIONS
APPROVED ENGINEERING SERVICE UNIT
Modern engineering demands precise standards of heat insulation performance. Pabco Precision Molded 85% Magnesia combines the time-tested superiority of Magnesia with precision molding to give you a light weight insulation manufactured to very close tolerances.
LIGHT WEIGHT
Pabco Precision Molded 85% Magnesia weighs just 11 lbs. per cubic foot. In addition to its light weight, it also brings many timely advantages, including easy application and greater rind strength.
Simpler and easier to apply! Easier to lift, cut and score. Simpler to imbed tie wires flush in the surface, too!
CLOSE TOLERANCES
Pabco's plus tolerance is only ½ lb. per cubic foot! This means an amazing degree of control over such factors as Weight and Thermal conductivity. Other controlled factors include size, thickness and uniform fibre distribution.
Precision pipe fit! Both pipe coverings and blocks are molded to exact final size and thickness, not molded oversize and then "milled" to size.
THE DEPENDABLE STANDARD — "MODERNIZED"
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PABCO PRODUCTS INC.
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Since 1920
PABCO ENGINEERING SERVICE UNITS IN ALL PRINCIPAL CITIES

MEASURE THESE VALUES WHEN YOU BUY METERS

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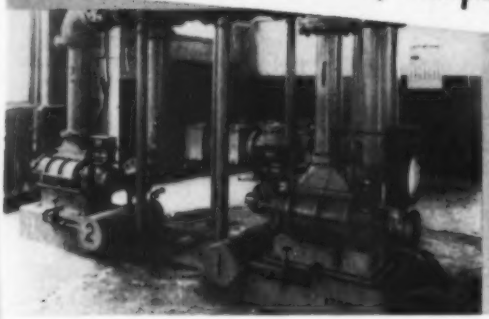

Part of an installation of nine R-C Positive Displacement Meters in large chemical plant. Capacities from 3,000 cfh to 130,000 cfh.

Industrial buyers rate R-C Positive Displacement Meters "tops" in these basic essentials.

Accuracy—Not affected by pressure, wide variations in loads or other variables. Simple design, with no vanes, valves or small parts, results in maintained accuracy over long years of operation.

Capacity—from 4,000 cfh to 1,000,000 cfh in one unit, to meet practically any industrial metering requirements. Ample ability to absorb overloads.

Compactness—foot for foot of capacity, R-C Meters are the smallest made for industrial use. Can be "tucked away" in relatively small space without loss of valuable production area.

These values have long been proved by large and small industrial plants and public utilities. More R-C Meters are used by gas producing plants, for their own manufacturing and for commercial customers, than any other make. For details on sizes and construction, ask for Bulletin 40-B-14.

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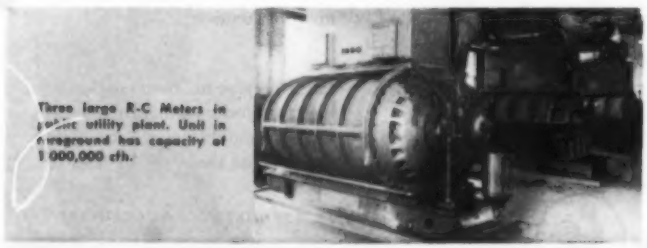


Three large R-C Meters in gas utility plant. Unit in foreground has capacity of 1,000,000 cfh.

ROOTS-CONNERSVILLE

ONE OF THE DRESSER INDUSTRIES

[What's Happening]

laboratory of Standard Oil Company (Indiana).

Dr. Harban joined Standard in 1948 as a chemist. He did his undergraduate and graduate work at Purdue University.

Five Professors Scheduled For Humble Science Lectures

Humble Oil and Refining Company's seventh annual series of lectures in science, which will be held at the company's Baytown, Texas, refinery, will include five professors from schools well scattered geographically.

Dr. Henry Eyring, professor and dean of the Graduate School, University of Utah, will lead off in November with a course on kinetics and catalysis. He will be followed by Dr. Joseph O. Hirschfelder, professor and director of the Naval Research Laboratory, University of Wisconsin, in January. Dr. Hirschfelder will speak on transport properties of fluids.

In March, 1953, Dr. Frederick G. Bordwell, assistant professor of chemistry, Northwestern University, will conduct a course on chemistry of organic sulfur and nitrogen compounds. Dr. Joseph C. Elgin, professor and associate dean of the school of engineering, Princeton University, will lecture on solvent extraction on April 1. Dr. Richard G. Folsom, division of mechanical engineering, University of California, will present a course in fluid mechanics in June.

Each of the courses extends over approximately two weeks and is a full time assignment for the members of Humble's technical staff who participate.

R. J. Painter, R. E. Hess Elected to ASTM Positions

The American Society for Testing Materials has announced the election of Robert J. Painter as executive secretary of the Society and Raymond E. Hess as associate executive secretary and editor in chief.

This action was taken by the board of directors following a report of a special committee which had been appointed to recommend a successor to the late C. L. Warwick, long-time executive secretary of the Society, who recently died.

Both Painter and Hess have been members of the ASTM for many years. Painter has been treasurer and assistant secretary, and Hess has been assistant executive secretary and editor.

Tetraethyl Lead Authority Retires from Du Pont

E. I. du Pont de Nemours and Company, Inc., has announced the retirement of Joseph L. Strecher, assistant director of sales of the company's petroleum chemicals division. He has been with the company for 37 years. He has been connected with tetraethyl lead production and sales almost continuously since 1923.

Strecher joined du Pont in 1915 as a laboratory assistant. During the next eight years he served in various supervisory capacities at the Niagara Falls, N. Y., plant. In September, 1923, when du Pont embarked upon full scale plant production of tetraethyl lead, he was appointed chief supervisor of the tetraethyl lead area at the company's Chambers

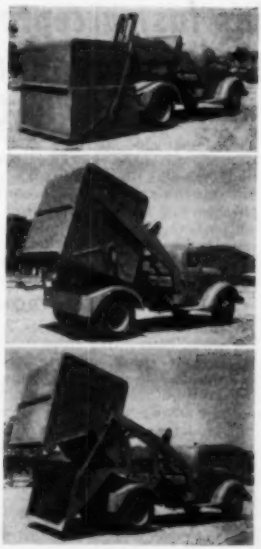
One DEMPSTER-DUMPSTER Serves Scores of Containers . . All Designs . . . All Sizes . .

Handling Materials of Almost Every Description at the Lowest Possible Cost!

One Dempster-Dumpster mounted on one of your trucks serves any required number of big detachable Dempster-Dumpster Containers spotted at convenient materials accumulation points inside and outside your buildings. The capacity of these containers range up to four times greater than the average dump truck body. They are built in a wide variety of designs best suited to the materials handled—be they solid, liquid or dust . . . trash or rubbish . . . bulky light or heavy. The truck-mounted Dempster-Dumpster, with only one man, the driver, picks up one pre-loaded container after another, hauls it to destination where materials are dumped or load set down intact. The Dempster-Dumpster may handle raw materials on one haul, liquids on another, trash and rubbish on another, etc. It's like having one truck with 15, 25, 65 or 100 different bodies.

This is the *Dempster-Dumpster System*—the modern method of bulk materials handling. It is saving thousands of dollars annually for hundreds of plants in every type of industry because it: Eliminates 3 to 5 conventional trucks and crews—reducing cost of truck equipment and operation accordingly. . . Eliminates standing idle time of trucks and crews. . . Eliminates re-handling of materials. . . Increases efficiency, sanitation and good housekeeping.

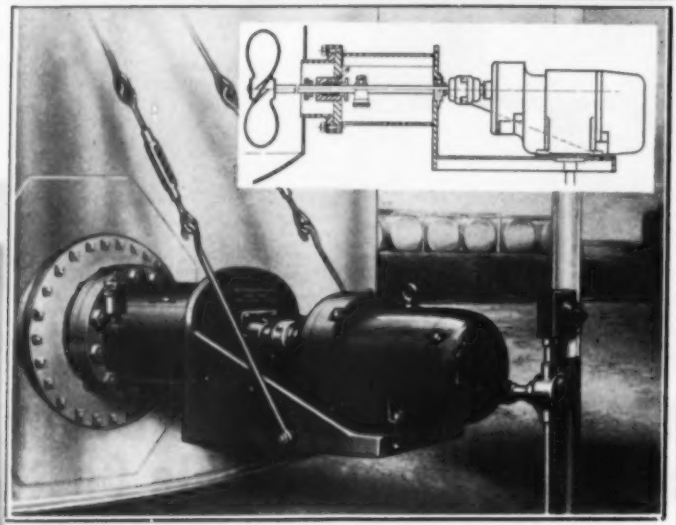
The *Dempster-Dumpster System* is, without question, the most efficient method of materials handling by truck ever devised! More efficient and lower cost materials handling in your plant may be simply a matter of getting the minds of your engineers and ours together. Write us now. The *Dempster-Dumpster System* is manufactured exclusively by Dempster Brothers, Inc.



WHEN A CONTAINER is full, the Dempster-Dumpster picks it up, hauls it to destination and dumps the materials or sets the load down intact. These three simple operations, shown above, are hydraulically controlled by driver in truck cab.

DEMPSTER BROTHERS, 5102 Dempster Bldg., Knoxville 17, Tennessee

International's Type "NU" SIDE ENTERING MIXER



Wins fast acceptance! Users say it meets all requirements. Costs less to buy and Fully Guaranteed!

Here is a mixer that has no cast parts, being of all-welded construction, including the stuffing box,—nothing to break or get out of order. And due to its strong, simple construction it is replacing many complicated, and higher priced units. It is recommended for the most efficient, rapid and economical blending of gasoline, gasoline Ethyl mixing, lubricating and fuel oil blending as well as by-products. Indispensable in cycling operations and pipe line work—uniformity in charging stock—a natural for research, laboratory and pilot plants.

12 SIZES—FROM ½ TO 25 H. P.

This unit has two ball bearings, and a front single lantern bearing on the shaft, thus giving three bearing supports to the overhung propeller shaft. Quick access to the front ball bearing and the stuffing box gland is obtained by opening the hinged cover door on top. Repacked from outside without tank leakage.. achieved by the same positive arrangement as our other models.

If you have a mixing problem, we invite you to write us for Catalogs and any special Engineering information you may need. There is no obligation of course.

Look to **International**
FOR DEPENDABLE MIXING EQUIPMENT

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Works. He is credited with ironing out many of the early production difficulties involved in the manufacture of tetraethyl lead.

Filtrol Appoints Ewing As Research Director

Announcement has been made of the appointment of Dr. F. J. Ewing as director of the recently expanded research department of the Filtrol Corporation, to replace Robert B. Secor, who has been promoted to administrative assistant to Gustave E. Kidde, manager of the manufacturing and technical departments.

Ewing

Dr. Ewing has been active in the research field for the past 22 years, during which time he has served as research chemist for the Union Oil Company of California, chief chemist for the Aero-Jet Corporation, special consultant to the chief of Ordnance, War Department, and in many other executive positions.

Corrosion Engineers Plan Second Annual Conference

The western region of the National Association of Corrosion Engineers has scheduled its second annual corrosion conference for November 20-21 at the Biltmore Hotel in Los Angeles.

Topics devoted to the general theme—applied research—will be discussed during the two-day session by nationally recognized corrosion engineers. Included in the program are a group luncheon on the first day, and, on the second day, a dinner which will provide the opportunity to discuss mutual problems with both suppliers and fellow workers.

Housing is on an individual basis, and advance registration may be made through W. M. Schilling, conference chairman and regional chairman. The registration fee is $3.00.

Hooker Transfers Kischitz and Wilkenfeld

Alexander D. Kischitz, graduate chemist from the University of New Hampshire, has been placed in charge of the research technical literature at the Hooker Electrochemical Company, and Jerome Wilkenfeld, chemical engineering graduate from City College of New York, has been appointed supervisor of process study. Both men have been associated with the company since 1943. Prior to the transfers, Kischitz served as a research chemist, and Wilkenfeld was a group leader.

Octane Rating Hikes Near Limit Says Gulf Researcher

The octane race is over, according to R. J. S. Pigott, director of the engineering division of Gulf Research and Development. At the seventh annual petroleum conference of the American Society of Mechanical Engineers, Pigott, who is

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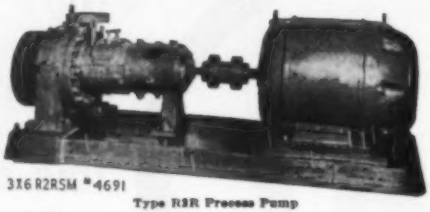

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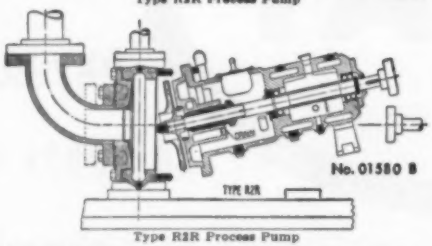

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DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R. Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
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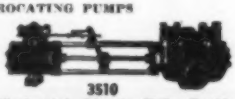

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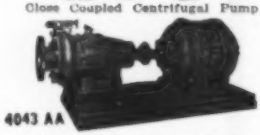

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Duraloe Duplex Packed Piston Pattern Steam Pump, Side Pot Type

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also president of the society, said:

"There is a limit to maximum octane value, even with catalytic cracking. This limit has been about reached and the indications are presently that we will have no further major increases in octane rating."

He earlier had qualified his statement by saying, "Unless someone develops entirely new refining processes not now known."

Symposium Will Feature AIChE Sectional Meeting

The seventh annual technical meeting of the South Texas Section AIChE will be held October 24 at the Rice Hotel, Houston. In the morning there will be a symposium on fractionating trays as well as a student meeting. In the afternoon a general meeting will run concurrently to a symposium on the production and purification of aromatics.

The fractionating tray symposium will include papers on bubble-cap trays, perforated trays, Turbogrid tray and Kaskade trays. The afternoon symposium will include papers on the Arosorb process and the Shell extractive distillation process. Other papers are on the subjects of acetylene from hydrocarbons, application of radioisotopes to chemical engineering, design of tubular process heaters and economics in engineering.

The evening functions include a cocktail party and a banquet. Sidney Kirkpatrick of *Chemical Engineering* and *Chemical Week* will be the evening's speaker. John J. McKetta of PETROLEUM REFINER is chairman for the meeting and master of ceremonies for the evening.

Major Role to Be Played in Jet Fuel by Small Refiners

Small refiners were recently urged to get into jet fuel manufacture at Atlantic City, N. J. as disclosures came about the new military specification JP-5.

A prediction was made in the jet fuels symposium at the 50th anniversary meeting of the National Petroleum Association that the jet fuel demand for commercial aircraft in 1957 will be 1.1 million barrels and in 1962, about 4.8 million barrels.

The opinion was expressed that jet fuels are the small refiner's aviation "gasoline" and these refiners can help themselves and the defense effort by production of these fuels. Refiners were urged to familiarize themselves with the new JP-5 specifications.

14 Attend Stanolind School To Study Process Engineering

A three-week course in process engineering was recently held in Tulsa, Okla., under the sponsorship of Stanolind Oil and Gas Company. Fourteen engineers, representing 11 Stanolind operated gasoline plants, the company's one refinery and the general office engineering section, attended to study advanced process engineering as applied to plant operation. Some of the subjects covered were: "Heat and Material Balances for Process Equipment," "Phase Characteristics of Hydrocarbons," "Principles of Absorption and Distillation" and "Process Vessel Rating."

James F. Pollock, senior process en-

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In this economical Chemico process, spent alkylation acid is sprayed into a furnace maintained at a high heat with auxiliary burners. Sulfur or hydrogen sulfide may be used as fuel thereby producing SO_2 gas for the production of make-up acid.

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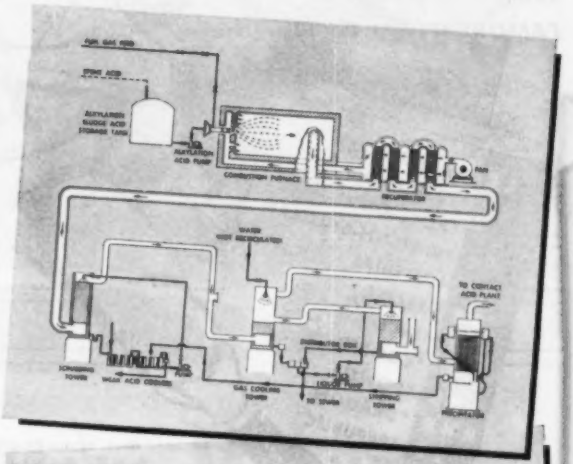
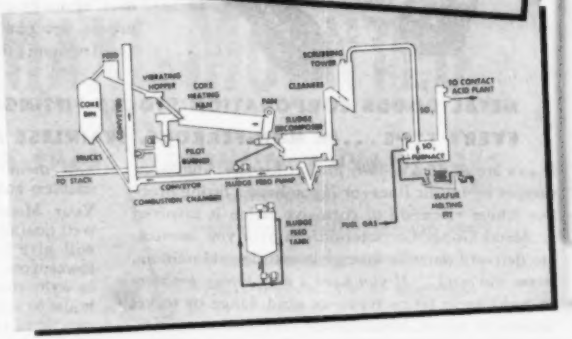


from Refinery Sludge

This proved and practical process offers three important advantages. (1) The purified SO_2 gas provides a product acid that is free of carbon contamination. (2) The resulting H_2SO_4 may be 98% or any higher strength regardless of the initial strength of the sludge. (3) Sludges that cannot be processed by other methods may be satisfactorily used in this system.

As shown in the diagram, unseparated acid sludge is continuously decomposed in a closed, fumeless system into a strong SO_2 gas and a dry granular coke of value as a byproduct fuel. After passing through a simple purification system, the SO_2 gas is converted into H_2SO_4 in a standard Chemico contact acid plant.



You can profitably produce much needed sulfuric acid, if you have either of these waste acids in commercial quantities. Chemico will design and construct the complete plant . . . deliver it in smooth-running operation on a performance-guaranteed basis. For specific recommendations, write us describing your problem fully.

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gineer who has been with Stanolind since 1946, was in charge of instruction at the school which is the second Stanolind has conducted in process engineering. Instructors were drawn from the plant engineering group and the process division of the company's research laboratory.

Attending the school were: C. B. Burleson, Sundown, Texas; J. D. Cranor, Ulysses, Kan.; B. C. Edwards, Midwest, Wyo.; G. H. Ellinger, Andrews, Texas; S. L. Forrester, Vivian, La.; J. T. Hearne, Vivian, La.; F. K. Kennedy III, Alvin, Texas; J. R. Malin, Elk Basin, Wyo.; R. Z. Mason, Levelland, Texas; R. F. May, Pettus, Texas; J. E. McCollum, Tulsa; W. L. Richards, Odessa, Texas; H. T. Shirley, Andrews, Texas; and K. H. West, Jennings, La.

Caltex Announces Appointments Of Four to New Executive Posts

Appointments to four executive posts in Australia and the Philippines have

Parker Miller

been announced by the Caltex Group.

A. J. Herron has been appointed general manager of Australian Oil Refining Pty., Ltd., in charge of operations of the new company. R. W. Parker has been appointed project manager in charge of all phases of design, field construction and other activities related to the erection of the company's refinery at Kurnell, Australia.

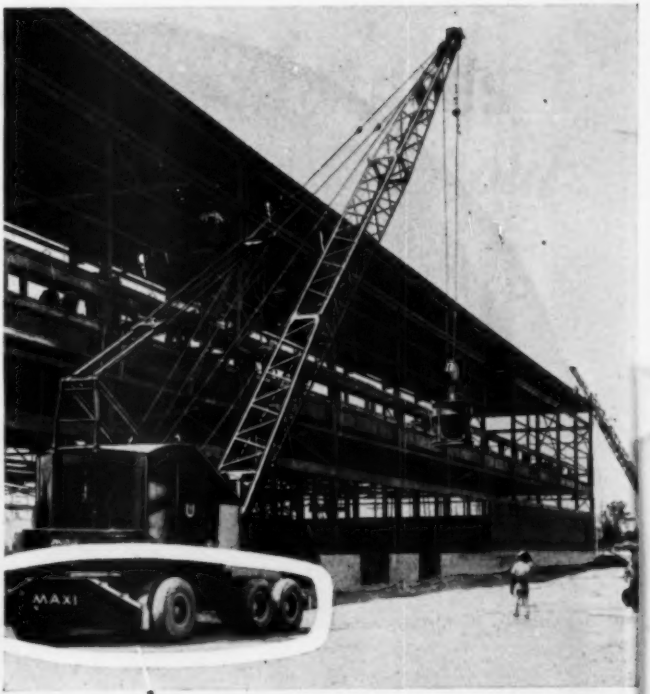
W. G. Miller has been appointed project manager in charge of all phases of field construction, field designs and other activities related to the erection of the refinery of Caltex (Philippines), Inc. L. D. Josephson has been selected for the post of refinery manager of Caltex (Philippines), Inc.

Synthetic Fuels Years Away Research Head Tells AAA

In the opinion of Joseph K. Roberts, general manager of research and development for Standard Oil Company (Indiana), oil shale, coal and tar sands will be the sources of fuels 10 or 15 years from now.

Participating in a panel discussion of "What's Ahead for the Motorists" at the recent American Automobile Association convention in Washington, Roberts said that more and more petroleum reserves are being found but indicated that greatly increasing demand would eventually require utilization of synthetic fuels.

Answering questions from the audience, Roberts explained that the industry suggest 1000-mile oil changes. As for



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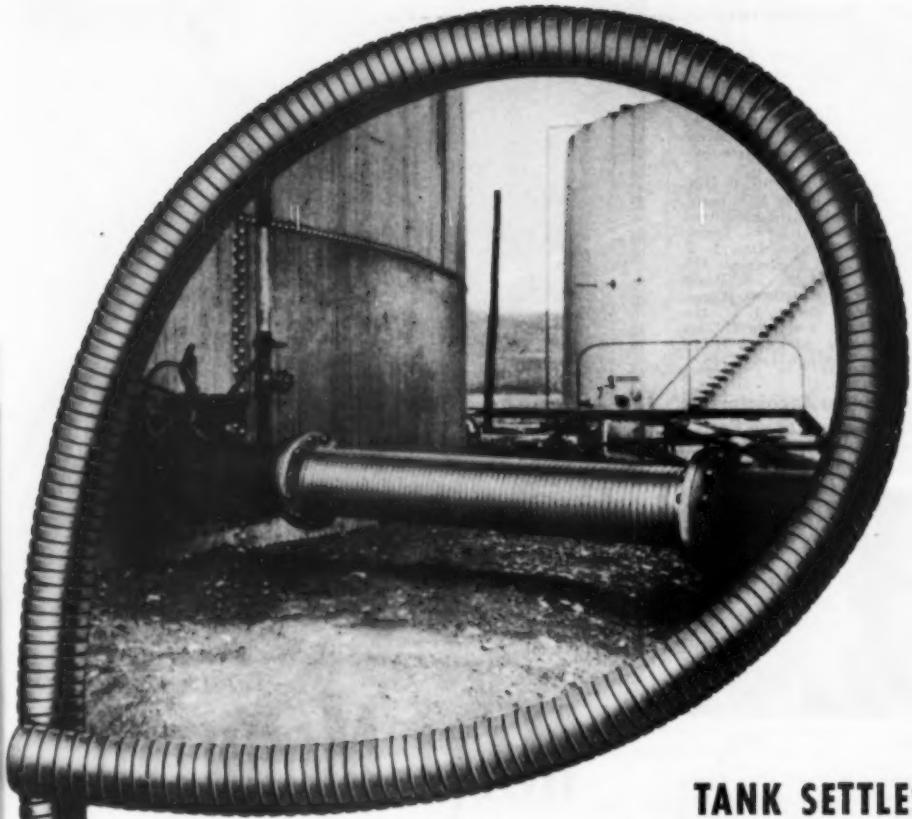

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premium gasoline as opposed to regular, he said if a motor doesn't knock using regular, there's no point in buying a more expensive grade.

Stockdale Promoted to Post At New Standard Refinery

The Standard Oil Company (Indiana) has announced that Thomas E. Stockdale, general superintendent of the company's Wood River, Ill. refinery, has been promoted to manager of the new refinery which Standard plans to build at Mandan, N. D.

Ford H. Blunck, manager of Standard's projects, capital expenditures and miscellaneous contracts division, succeeds Stockdale at the Illinois plant.

Stockdale joined Standard in 1923 as a designer and draftsman at its Whiting, Ind. refinery, later serving as department foreman of the paraffine and heavy oils division. In 1931 he became assistant superintendent of the heavy oil department and in 1942 assumed duties as superintendent of the Wood River refinery. Blunck has been with Standard since 1936. He served as a chemist in the research department at Whiting until 1940, when he became a group leader in technical service. He became superintendent of the projects division at Whiting in 1950 and in 1951 was advanced to the position he held prior to the recent transfer.

High Fringe Benefits In Oil Refining Are Reported

Fringe benefits paid employes in the oil refining industry averaged $975 in 1951, in addition to regular payroll costs, according to a survey by the U. S. Chamber of Commerce. The report showed that the average for all industries for the same period was $644.

The Chamber said that the "hidden" payroll in oil refining represented 22.5 percent of total payroll and came out to an hourly cost of 46.4 cents per payroll hour. The survey revealed that fringe payments are at an all-time high and are mounting steadily.

Koppers "Loans" Keeling To NPA Chemical Division

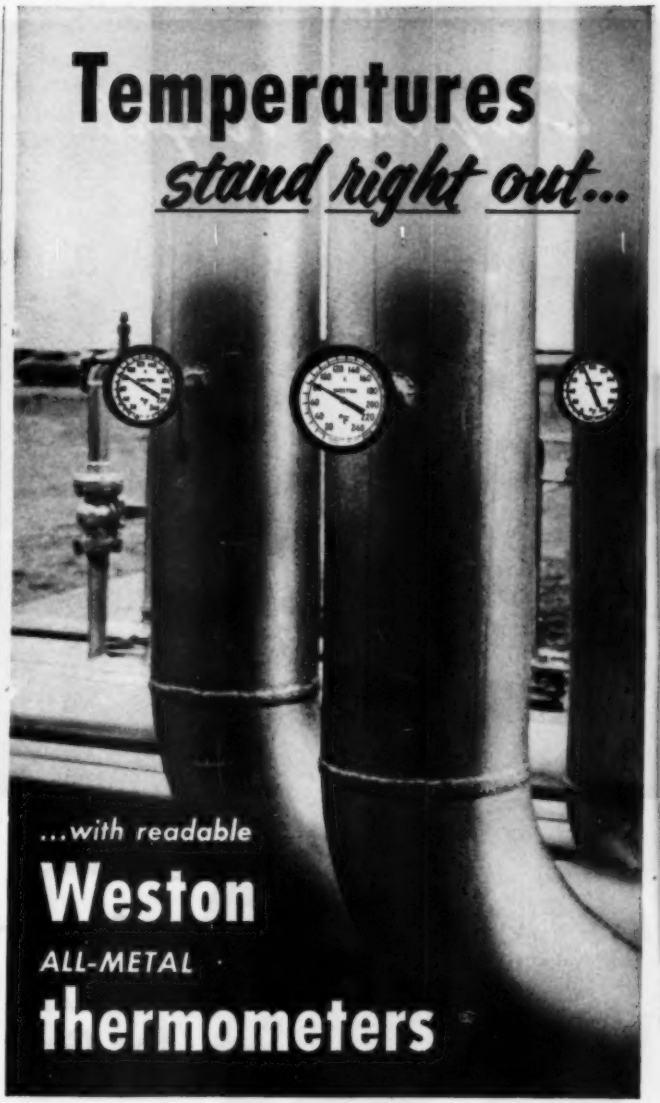
T. C. Keeling, Jr., assistant vice president and chemical division sales manager of Koppers Company, Inc., has assumed the duties of deputy director, chemical division of the National Production Authority.

Dan M. Rugg, vice president and general manager of the Koppers' division, said that Keeling was being "loaned" to the government for six months at the request of George E. Holbrook, director of the chemical division, NPA. Keeling will return to his duties with Koppers on March 15, 1953.

Lynde to Take OIIC Post As District Representative

W. T. Lynde has been appointed as senior district representative for the Gulf-Southwest district of the Oil Industry Information Committee, American Petroleum Institute, to succeed Don Agnew, resigned.

Headquarters for the district, which covers N. M., Texas, La., Miss., Ala.,



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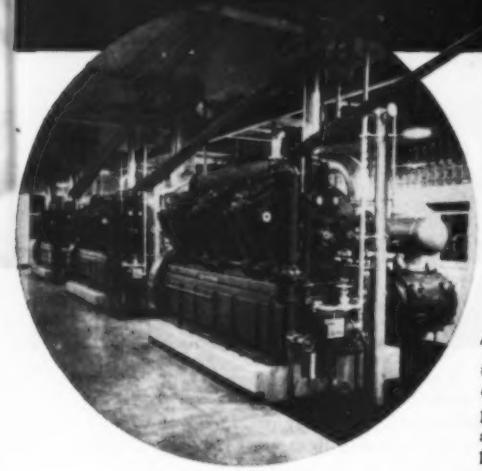

Uses **SVG**

Gas-Engine-Driven COMPRESSORS for Gas Concentration

The new U.O.P. fluid catalytic cracking unit recently installed at the McMurrey Refinery, Tyler, Texas, gives this progressive oil company an added capacity of 4000 barrels of charge stock per day. To assure uninterrupted service, night and day, year after year, every item of associated equipment has to meet the highest standards of dependability, performance and economy.

The gas-concentration compressors selected for this important job are three Ingersoll-Rand Type SVG gas-engine-driven units. The SVG, also built in 440-hp size, is the new machine that is essentially a modernized version of the famous XVG. Let us tell you more about the SVG, and other sizes in the I-R 4-cycle line . . . gas engine compressors from 110 hp to 1320 hp . . . gas engines to 1760 hp.

Ingersoll-Rand
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and Ark., is Dallas, with sub-offices in New Orleans and Jackson, Miss.

Lynde joined the OIIC in Dallas in November, 1950, and has been working on the industry's public relations program, especially in the states of Texas and N. M. Previously he was the publicity manager for the Texas and Pacific Railway Company.

Legal Barrages Unleashed By "Cartel" Disputants

Recent major developments in the "international cartel" altercation have been on the order of legalistic maneuvers. So that member companies of the alleged cartel could take advantage of any court decision rendered October 1 on the validity of the subpoena and jurisdiction of the grand jury sitting in Washington, the Justice Department granted an extension of the subpoena compliance date until October 10 to individuals summond as witnesses before the grand jury and to the 12 companies which have agreed to furnish requested records.

At the same time, two new motions were being filed in the U. S. District Court in Washington attacking the District of Columbia locale of the grand jury whereas the companies—Socony-Vacuum and Standard Oil Company of California—had to meet a second government suit (MSA overcharge allegations) simultaneously in New York. Both motions called for the quashing of the subpoena and transfer of the grand jury investigation to New York. Both attacked the fact that the 23-member Washington grand jury contained 14 government employes.

Judge James R. Kirkland had been named to hear the arguments.

Lincoln Announces Program For $30,000 Design Award

A new competition for designers, engineers and manufacturers of machinery of all types has recently been announced by The James F. Lincoln Arc Welding Foundation of Cleveland, Ohio. The new Mechanical Design Award Program offers $30,000 in 101 cash awards, as well as national recognition, for the best papers describing the mechanical design and construction of any type of machine component which is designed for arc welded steel fabrication.

Papers will be judged by a jury of engineers, educators, designers and fabricators selected from men prominent in industry and education. The program closes July 27, 1953. The rules and conditions brochure is available from the Lincoln Foundation, Cleveland 17, Ohio.

Walter Kidde Constructors Appoints New Vice President

Walter Kidde Constructors, Inc., engineers and builders, recently announced the appointment of Taylor Milton as vice president.

Milton has been vice president and chief engineer of Walter Kidde Engineer-Southwest, Inc., a subsidiary with headquarters in Houston. He will continue in this capacity, in addition to his new duties.

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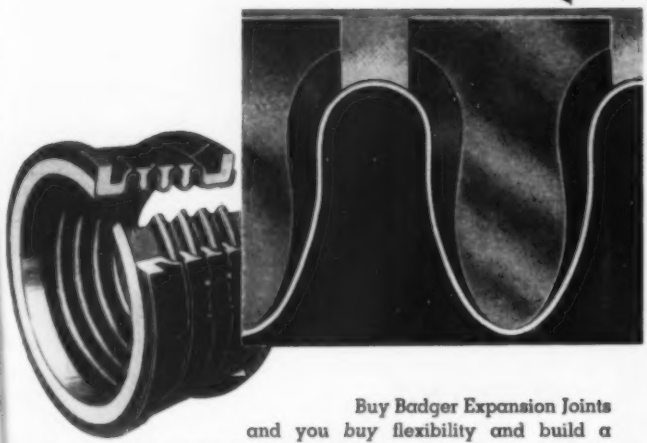

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ciety of Heating and Ventilating Engineers, Texas Society of Professional Engineers and the National Society of Professional Engineers.

Dow Chemical Names Parish Chief Engineer, Texas Division

The appointment of J. M. Parish as chief engineer of its Texas division was recently announced by the Dow Chemical Company. He will be responsible for the operations of Dow's engineering department.

A graduate of Texas A. & M. College in mechanical engineering, Parish joined Dow in Midland, Mich. in 1940 as a student engineer.

Rugh Becomes Manager Of Phillips PR Department

Phillips Petroleum Company has announced that K. W. Rugh has become manager of its public relations department replacing Chester W. Cleveland, resigned. It was also announced that Fred Pralle will become publicity director reporting directly to Rugh.

Rugh has been in the service of Phillips for more than 22 years. During the first 17 years he was engaged in the sales and distribution of liquefied petroleum gases. He has served as assistant manager of the sales department during the past five years.

Refining Picture To Be Given By 30th Petroleum Exposition

The 1953 International Petroleum Exposition, called the "World's Fair of the Oil Industry," is planning to present a better picture of the refining division than ever before at its thirtieth anniversary exposition on May 14-23.

Over 300 exhibitors of nearly 1,000 at the last show in 1948 featured refinery equipment and technical methods. Indications at this time point to a much greater display.

Exhibitors will present many working models as well as charts and other displays describing and explaining many of the refining processes being utilized and developed today.

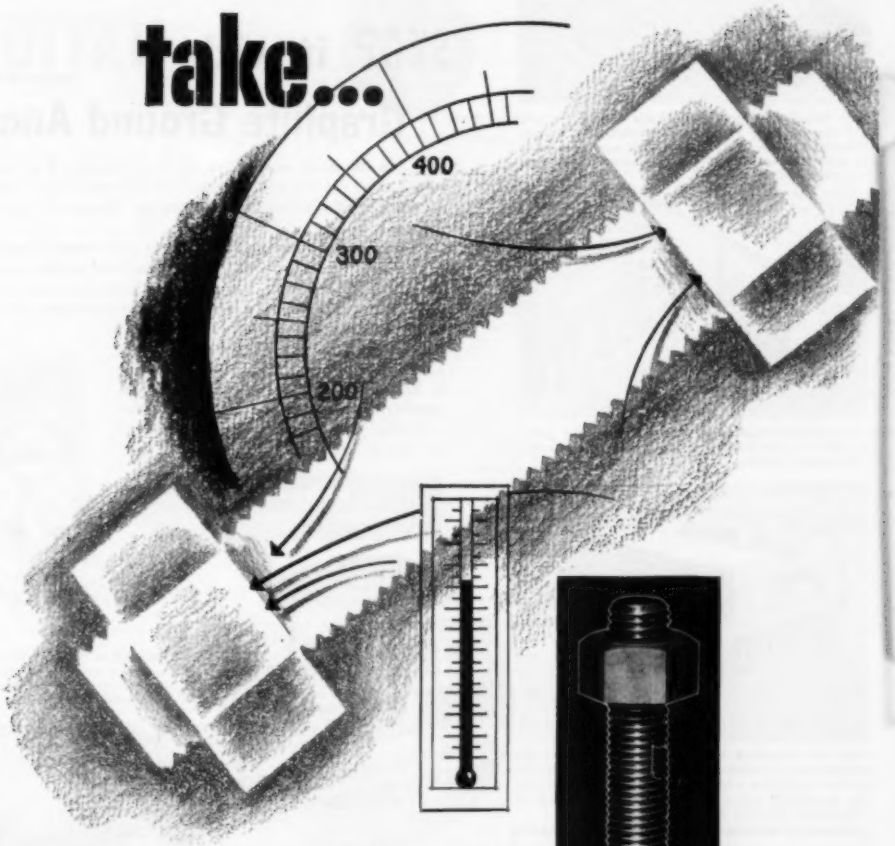
Garwin Named Director

Dr. Leo Garwin has been named acting director of research for Kerr-McGee Oil Industries, Inc., succeeding Dr. George Agoston, resigned. Dr. Garwin has been project leader in the company's research department since June 1, 1951, and was for four years a professor at Oklahoma A. & M. College, Stillwater. He received his Ph.D. degree from the University of Pennsylvania. The company's research laboratories are located in Oklahoma City.

Sandy Sandberg Dies

The recent death of J. W. (Sandy) Sandberg, refinery manager for the Lakeside Refining Company, has been announced by that firm. Sandberg, who came to Lakeside from the Perco division of the chemical products department of Phillips Petroleum Company, was at one time associated with Trinidad Leasehold, Ltd., for six years in Trinidad, British West Indies.

no give... plenty of take...



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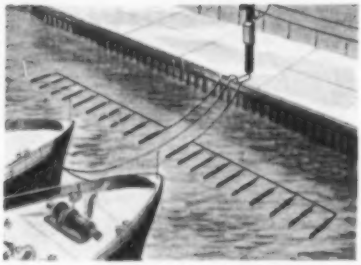
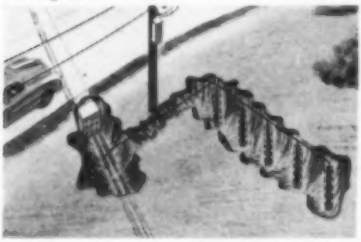
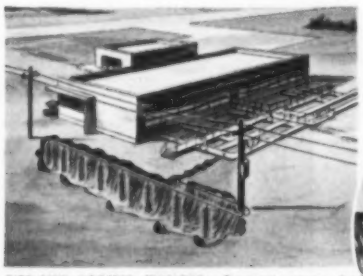


SHIP HULLS – Inactive ship hulls are effectively and economically protected with remotely located "National" Ground Anodes. Active vessels also can be protected with anode plates mounted on or near the bilge keel.



LEAD-COVERED CABLES – Both telephone and power cables are cathodically protected in many areas with "National" Anodes.



PIPE-LINE BOOSTER STATIONS – In most cases the underground structure of a pipe line booster station, which represents a large monetary investment, can be protected by a single, inexpensive bed of "National" Ground Anodes.

You can do much more than *arrest* corrosion. You can *eliminate it completely* – at a fraction of the cost of maintenance and replacement – with cathodic protection, employing "National" Graphite Ground Anodes.

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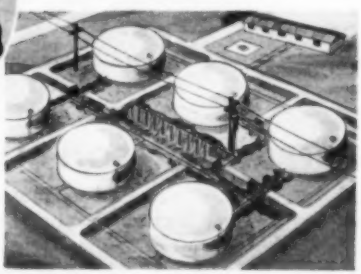
WRITE FOR CATALOG SECTION S-6510

INDUSTRIAL PLANTS – External corrosion of buried or submerged metal structures can be completely eliminated by the use of "National" Ground Anodes.



TANK FARMS – The cost of a complete "National" Anode installation for the protection of a tank farm, including the cost of rectifiers, is frequently paid for within a very few months with savings from reduced structure maintenance.

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New Science and Technology Abstracts

Fundamental Physical and Chemical Data

Two-phase Equilibrium in Binary and Ternary Systems.

VIII. The integral flash latent heat at constant pressure of the system ethylene-carbon dioxide.

A. J. Barnard, S. P. Luthra, D. M. Newitt, and M. U. Pai, *Proc. Roy. Soc. (London)* **A209** (1951), pp. 143-57.

The authors describe a procedure for determining the integral flash latent heat of a binary mixture at constant pressure, and give the results for the system ethylene-CO_2. Experimental results are compared with calculated results. The possible error in the work is given as two percent.

Hydrocarbon Burning Velocities Predicted by Thermal Versus Diffusional Mechanisms.

P. L. Walker, Jr. and C. C. Wright (Division of Fuel Technology, Pennsylvania State College, State College, Pa.), *Jour. Am. Chem. Soc.* **74** (1952), pp. 3769-71.

The authors predict the maximum burning velocities of 36 hydrocarbon-air mixtures by using the semi-empirical thermal equation of Seminov. The results so obtained were compared with N.A.C.A. experimental velocities and those predicted by the semi-empirical equations of Tanford and Pease. Both of these correlations are based on the assumption that the specific reaction rate constant for the chemical reactions controlling the respective mechanisms are independent of the hydrocarbon involved. The thermal correlation, as well as the diffusional theory, show that the combustion mechanism is similar for the majority of hydrocarbons. If a constant frequency factor is assumed in the Seminov equation, a variation of less than five percent in the activation energy brings the thermal result into line with experimental velocities for all mixtures except ethylene and acetylene. The correlation between burning velocity and equilibrium flame temperature is presented in graphical form. Burning velocities, as found experimentally and as calculated by the Seminov equation and the Tanford equation are presented for a long list of hydrocarbons in the form of a table.

Physical Properties of Perfluoro-n-hexane and Perfluoro-2-methylpentane.

Vernon E. Stiles and George H. Cady (Department of Chemistry and Chemical Engineering, University of Washington, Seattle 5, Washington), *Jour. Am. Chem. Soc.* **74** (1952), pp. 3771-3.

Two isomeric perfluorohexanes were prepared by fluorinating the pure hydrocarbons with cobalt trifluoride. The products were purified by fractional distillation and the best cuts of each were combined. These were used in determination of melting points, vapor pressure, surface tension, viscosity, density and index of refraction. The normal fluorocarbon is the less dense, the less viscous and the more volatile. Also its surface tension and index of refraction are lower. Although the liquids appear to be similar, their physical properties differ and in directions opposite to those of the difference between the corresponding hydrocarbons. In this regard these compounds resemble perfluoro-n-pentane and perfluoroisopentane.

Chemical Composition and Reactions

Composition of Virgin, Thermal, and Catalytic Naphthas From Mid-Continent Petroleum.

William E. Cady, Robert F. Marschner, and Wendell P. Cropper (Standard Oil Co. of Indiana, Whiting, Ind.), *Ind. Eng. Chem.* **44** (1952), pp. 1859-64.

The authors briefly review the status of our knowledge of the composition of petroleum fractions in the ranges of 5- to 10-carbon, 10- to 20-carbon, and over 20-carbon. The paper then presents the composition of the light naphthas obtained from three different processes from Mid-continent petroleum. The first was a virgin distillate representing the lightest 20 percent of the petroleum. The second was a cracked naphtha obtained by the thermal cracking of the heaviest 70 percent of the oil. Third was a cracked naphtha obtained by the catalytic cracking of the 30 to 70 percent fraction. Thermal cracking of the heavy part of Mid-continent petroleum results in light products that bear a definite resemblance to the lighter hydrocarbons present in the original petroleum. Catalytic cracking of the intermediate parts of the petroleum gives light hydrocarbons that bear little resemblance to the hydrocarbons in the virgin petroleum. Fundamental research with pure hydrocarbons indicates that thermal cracking proceeds through a free-radical mechanism, but that catalytic cracking proceeds through a carbonium ion mechanism. The catalytic product results from extensive isomerization and hydrogen transfer processes. The occurrence of these reactions prevents relating the catalytic naphtha to the presumed structure of the heavier hydrocarbons originally present. The data are presented in considerable detail in tabular form and a bibliography of 11 references is included.

THESE abstracts prepared by DR. E. H. LESLIE and DR. H. B. COATS, The Leslie Laboratories, Traver Road, Ann Arbor, Mich., are selected from the current literature of science and technology, not including trade journals easily available. Photostatic copies of original articles can be obtained at nominal cost from The Library of Congress, Photoduplication Service, Washington 25, D. C. Complete or limited bibliographies covering special topics by title, by abstract or in complete manuscript will be prepared and furnished by arrangement with The Leslie Laboratories.

Hydrogenation of 2-Cyclopropyl-1- and-2-Alkenes. Isolation and Purification of 2-Cyclopropylalkanes.

Vernon A. Slabey and Paul H. Wise (Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio), *Jour. Am. Chem. Soc.* **74** (1952), pp. 3887-91.

A copper chromite catalyst with barium promoter was used in the selective hydrogenation of the double bonds in some conjugated cyclopropylalkene hydrocarbons. Two-cyclopropyl-1-alkenes were found to be hydrogenated readily to give 2-cyclopropylalkanes. On the other hand, 2-cyclopropyl-2-alkenes were hydrogenated only slowly to give mixtures of 2-cyclopropylalkanes and methylalkanes.

Cyclopropane-paraffin mixtures obtained were separated by azeotropic fractionation. Two-cyclopropylpropane, -butane, -pentane and -hexane were all obtained in high purity. Physical properties, including melting points boiling points, refractive indices, densities and heats of combustion of these compounds were determined. Additional evidence is presented to substantiate that a cyclopropyl ring conjugated with a double bond will add hydrogen by either a one, two- or a one, four-mechanism.

Reaction Between Methane and Steam in the Temperature Region 1000 to 1100 C.

Alvin S. Gordon (Central Experiment Station, Bureau of Mines, Pittsburgh, Pa.), *Ind. Eng. Chem.* **44** (1952), pp. 1857-9.

The work reported was a continuation of a study of the uncatalyzed steam-natural gas reaction at temperatures in the range 1200 to 1500 C. and at one atmosphere pressure. In the present work the temperature range was 1000 to 1100 C. At a total pressure of one atmosphere the results show that the reaction between methane and steam is a combination of the decomposition of methane, followed by the steam-carbon reaction. Until carbon is deposited as a result of the decomposition, the steam present behaves as an inert gas. The making of synthesis gas from methane and steam for the Fischer-Tropsch process proceeds smoothly at 900 C. on a nickel catalyst. At higher temperatures there is no problem in decomposing methane, with an efficient catalyst, but the gasification of the resulting carbon is so slow that an efficient catalyst for the reaction would be required before the process would be economically feasible.

Reactions of Hydrocarbons Induced by Alkyl Fluoride Boron Trifluoride.

IV. Stoichiometry of the Self-alkylation of Isobutane.

Conrad K. Donnell and Robert M. Kennedy (Sun Oil Company Research Laboratory, Norwood, Pa.) *Jour. Am. Chem. Soc.* **74** (1952), pp. 4162-4.

Isoparaffins undergo self-alkylation under the influence of alkyl fluoride and boron trifluoride. Two or more molecules of isoparaffin unite to form a higher molecular weight saturated hydrocarbon. The purpose of the present

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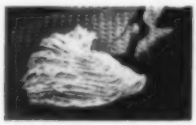

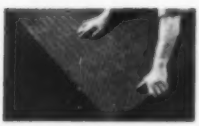

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work was to study the reaction quantitatively and to investigate its mechanism. It was found that the use of more than 0.5 moles of boron trifluoride per mole of isopropyl fluoride produced no additional reaction. The octanes resulting from the reaction are largely 2, 2, 4-trimethylpentane and other trimethylpentanes. Hydrocarbons other than the octanes are formed in extremely small amounts. In order to eliminate side reactions experiments were performed at —80 C.The reactants chosen were boron trifluoride, isopropyl fluoride and isbutane. Isopropyl fluoride was chosen rather than t-butyl fluoride so that it would be possible to distinguish the parraffin formed by saturation of the carbonium ion from the original isobutane charged. The mechanism of the reaction is discussed in some detail.

Sulphur in Oil Shale or Torbanite.

Geo. E. Mapstone and B. Nartsissov, (Coal Research Station, Box 3, Chatsworth, N.S.W.), *Jour. of Applied Chem.* **2** (1952), pp. 405-8.

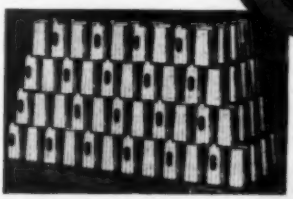
The sulphur compounds in oil shale may be classified as sulphate, pyritic and organic. Mott's rapid method for the determination of sulphate and pyritic sulphur in coal can be applied to oil shale, the pyrite content being calculated from the oil extracted. The organic sulphur is best calculated by subtracting the pyritic sulphur from the total sulphur content of the hydrochloric acid-extracted material as determined by the quartz-tube method. When the shale is decomposed approximately only one percent of the added pyritic sulphur appears as organic sulphur in the oil. Likewise, the addition of calcium carbonate has no effect, and calcium hydroxide only a slight effect, on the organic sulphur content of the oil. None of these materials affected the oil yield significantly. A bibliography of nine references is included.

Oxidation of Petroleum Residues.

W. Graham, W. J. G. Cudmore and R. D. Heyding (University of Saskatchewan), *Can. J. Technol.* **30** (1952), pp. 143-52.

The water and carbon dioxide evolved, as well as oxygen consumed, were measured in the conversion of oils and resins to asphaltenes during the oxidation of petroleum residues. Materials blown at 200 C. were a steam refined reduced crude and a cracked stock. Air oxidation of both stocks increased the asphaltenes in the residue at the expense of oils and resins. The oxidation of the reduced crude did not result in a large change in the oxygen content either of the oils or of the asphaltenes, although the oxygen content of the resins increased appreciably. In the case of the cracked residue the oxygen content of the resins and of the oils increased during the early stages of air blowing, decreased to a minimum value and increased slowly as oxidation continued. In contrast to the reduced crude asphaltenes, those from the cracked stock doubled in oxygen content per unit weight during the blowing period. In the oxidation of the reduced crude the resins were more susceptible to oxidation than the oil, whereas in oxidizing the cracked stocks oils disappeared more rapidly

This Monel tube bundle used in an HF Alkylation Unit Dehydrator Reboiler is an excellent example of the use of Monel to resist corrosive chemical attack even at high operating temperatures.



These plugs for 2-inch plug valves used in hydrofluoric acid alkylation service were machined from Monel rod. No. 130 Monel Arc Electrodes are used for overlaying steel plugs in larger valves.

How Monel muzzles HF ...even at high temperatures

Monel lined hydrofluoric acid regenerator column with 1/16" minimum lining of Monel. The two Monel grids are for holding the Raschig rings.

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Monel is comparatively insensitive to the effects of velocities which increase the corrosion rate of other materials. Therefore, it is suitable for valves, pumps and pipe lines, for impellers, stators and shafts, and for bubble caps and linings in hydrofluoric acid distillation columns.

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[Science Abstracts]

than the resins. The consumption of oxygen in treating the reduced crude was independent of the concentration of oxygen in the blowing medium. The rates of conversion of oils and resins to asphaltenes, per mole of oxygen supplied, were found not to be identical, but somewhat less when the blowing was with oxygen than when it was with air. Comparison of the quantity of oxygen evolved as water to the total oxygen consumed makes it evident that the primary reactions in the case of both residues involved dehydrogenation.

The Pyrolysis of Propylbenzene and the Heat of Formation of Ethyl Radical.

C. H. Lehigh and M. Szwarc (Univ. Manchester, England), *J. Chem. Phys.* **20** (1952), pp. 403-6.

Propylbenzene decomposes initially into benzyl and C_2H_5 radicals. C_2H_5 radicals decompose to ethylene and hydrogen atoms. The H atoms reacting with toluene produce H_2 or CH_4. The rate of the initial dissociation process can be measured by the rate of formation of C_3 hydrocarbons. Decomposition is a homogeneous, 1st-order reaction. The activation energy is given. It appears to be equal to the bond dissociation energy. The heat of formation of C_3H_5 radicals is calculated as 22 kcal. per mole.

The Pyrolysis of Butylbenzene and the Heat of Formation of Propyl Radical.

C. H. Leigh and M. Szwarc (Univ. Manchester, England), *J. Chem. Phys.* **20** (1952), pp. 407-11.

Butylbenzene dissociates into benzyl and propyl radicals. Propyl radicals decompose to give ethylene and CH_3 radicals. The activation energy of the dissociation was found to be 65 kcal. per mole. The dissociation energy of the primary GH bond in propane was calculated as 100 kcal. per mole. Other thermodynamic calculations are made.

Manufacture: Processes and Plant

Mass Transfer Coefficients and Interfacial Areas for 1-inch Raschig Rings.

H. L. Shulman and J. J. DeGouff, Jr. (Clarkson College of Technology, Potsdam, N. Y.), *Ind. Eng. Chem.* **44** (1952), pp. 1915-22.

The work reported was undertaken to resolve the gas-phase mass transfer coefficient, $k_g a$, into its components k_g and "a" in order that the effects of such variables as gas rate, liquid rate, and diffusivity could be determined separately for each component. An ingenious procedure using Raschig rings constructed of solid naphthalene was used so that the vaporization rate from dry rings and from wet rings could be compared, thus obtaining a measure of wetted area. The effective interfacial area was found to be somewhat greater than the wetted area and both areas were more dependent on varying liquid rates than on varying gas rates. An equation is given that is recommended for design purposes for calculation of k_g; $k_g a$ can then be obtained by multiplying k_g by the effective interfacial area, "a." The results are presented in

How CROSBY'S BALANCED AREA DESIGN eliminates back pressure effects

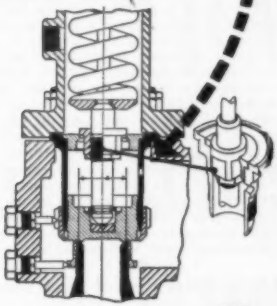


Fig. 1 Fig. 2

When a standard relief valve on gas or vapor service is installed, where back pressure exists, one of two undesirable effects will occur:

Constant Back Pressure — The back pressure acts on part of the upper and the overhanging part of the lower surface of the disc, cancelling out the back pressure force. There remains, however, a force acting on the top portion of disc (area A) which increases the spring load and causes the valve to pop "heavy."

Variable Back Pressure can not be compensated for by spring adjustments. When one or more valves discharge into a common flare header, variable back pressure is placed on the remaining closed valves. This can create a hazardous condition on remaining closed valves, by adding to the spring force. The valve then is prevented from opening until pressure has risen far above the vessel design limit.

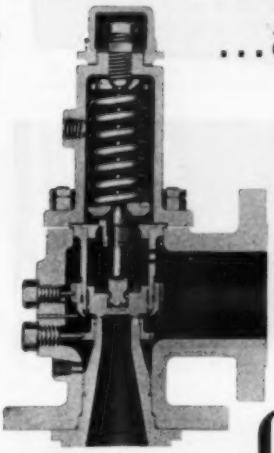
[redacted] is a simple, foolproof method of nullifying these undesirable effects (see Figure 1 above).

Operation — Crosby achieves *Stable Popping Pressure* by the addition of a piston affixed to the spindle, of area proportioned to equal the unbalanced area of the disc (area A in Fig. 1). Back pressure introduced through the port in the guide then acts on two equal areas in opposite directions, and cancels itself out, neither aiding nor opposing the spring.

To assure full lift and stability, a vent system (see sectional view of piston, Fig. 2) is employed. When the valve is open, the flats on the piston will vent any accumulated back pressure that would tend to close the valve. The adjustment and operating characteristics are similar to the conventional valve. The actual flow into the bonnet is relatively low and can be vented to atmosphere, or through a properly sized discharge header.

Extensive, trouble-free use in the field has proved the success of this Crosby Balanced Area Design.

Here's the [redacted] RELIEF VALVE which eliminates back pressure effects ...and reduces costs!



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with BALANCED AREA DESIGN
for the elimination
of Back Pressure Effects.

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On the many installations where Crosby JO-BP Valves have been in operation, refineries report sizable savings in piping costs. The reason—smaller discharge lines made possible by higher back pressure. Since Crosby JO-BP Relief Valves will handle back pressure surges ranging up to 90% of inlet pressure, smaller diameter discharge pipe carries the same amount over the same distance that formerly required much larger pipe.

Proved PROTECTION!

On-the-job performance of Crosby JO-BP Relief Valves proves that you can depend on the vented Balanced Area Design to operate on the set pressure. Thus you are assured of a *Stable Popping Point*. What's more, a full lift is obtained over the normal range of back pressures. The Crosby JO-BP operates with an unrestricted nozzle, follows standard nozzle flow equations for above or below critical ratio as the case may be. With its vented Balanced Area Design, the Crosby JO-BP provides a foolproof, time-tested method of eliminating back pressure effects.

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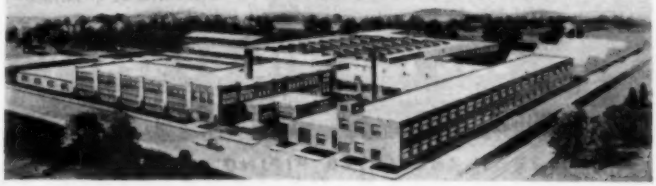

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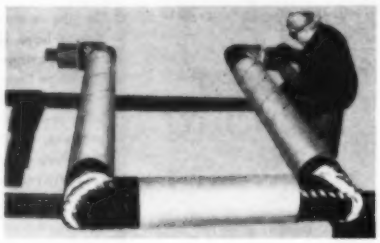

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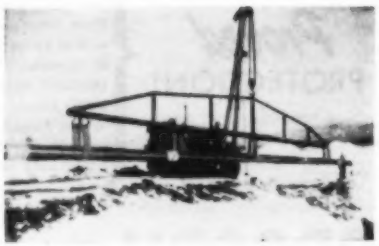

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some detail in tabular and graphical form and a bibliography of 20 references is included.

Pipe Resistance for Hydraulic Lubricating and Fuel Oils and Other Non-Aqueous Liquids.

T. E. Beacham. 61 pages. London, England: E. & F. N. Spon, Ltd. (1951), 18s.

The book presents methods for estimating pressure drop for the flow of oils, spirits and non-aqueous liquids in pipe. A series of charts is presented showing flow plotted against pressure drop for various pipe diameters and for liquids with viscosities from 30 seconds Redwood to 10,000 seconds, specific gravities of 0.82-0.90 and for three different degrees of pipe roughness. Charts are also given to convert Redwood seconds to Saybolt seconds and centistokes. Nomographs are given which can be used for calculating pressure drops or economic pipe diameters. These incorporate the viscosities of the liquids and vapors.

Metals Poisoning of Fluid Cracking Catalyst.

B. J. Duffy, Jr., and H. M. Hart (Standard Oil Company of Indiana, Sugar Creek, Missouri), *Chem. Eng. Progress* **48** (1952), pp. 344-8.

The operation of a fluid catalytic cracking plant at the Sugar Creek refinery of Standard Oil Company (Indiana) has provided data on the contaminating effect of metals in the cracking plant feed. A catalyst of good selectivity gives a high yield of gasoline, perhaps 93 barrels per 100 barrels of gas oil converted. On the other hand, a catalyst of poor selectivity may result in a gasoline yield as low as 82 barrels per 100 barrels converted. In operating a large unit this can result in a loss of several thousand dollars per day. Three different heavy gas oils containing metal were available at various times over a two-year period and were used successively as marginal cracking stocks. It has same period, two separate batches of catalyst were employed in the unit. Selectivity effects observed under these conditions, as well as the quantitative methods developed for predicting selectivity degradation and catalyst requirements for selectivity control, are the basis of the investigation reported in the paper. Data are presented in tabular form and a bibliography of seven references is included.

High-Pressure Hydrogenation of Crude Shale Oil.

M. G. Pelipetz, M. L. Wolfson, H. Ginsberg, E. L. Clark (Bureau of Mines, Bruceton, Pennsylvania), *Chem. Eng. Progress* **48** (1952), pp. 353-6.

Shale oil, as obtained by the thermal retorting of oil shale, is a high-gravity somewhat asphaltic oil containing approximately 2 percent of nitrogen and 0.7 percent sulphur. Such oil, obtained by retorting Colorado oil shale in a gas-flow retort, was hydrogenated over several different solid catalysts in a continuous high-pressure unit, using a once-through procedure. At 9000 psig hydrogen pressure and at temperatures between 800 and 900 F, a product essentially free of sulfur and nitrogen, and suitable for fur-

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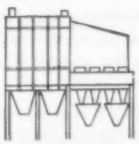

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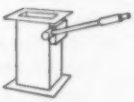

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ther processing by standard petroleum methods, was made. When tungsten or cobalt molybdate catalysts were used, 40 to 50 vol. percent of the product oil obtained through hydrogenation is utilizable as high-quality diesel fuel, having a cetane rating of 50 to 60. The hydrogen consumption was between 2000 and 2800 cubic feet per barrel of shale-oil feed, depending on the type of catalyst used and the temperature of the hydrogenation. It did not appear feasible to make a large quantity of high quality gasoline directly from crude shale oil by one step hydrogenation. Preparation of suitable raw material, or synthetic crude, for processing by conventional petroleum-refining methods appears quite feasible. A bibliography of ten references is included.

Experimental Catalytic and Thermal Cracking at High Temperature and High Space Velocity.

R. C. Archibald, N. C. May, and B. S. Greensfelder (Shell Development Co., Emeryville, Calif.), *Ind. Eng. Chem.* **44** (1952), pp. 1811-17.

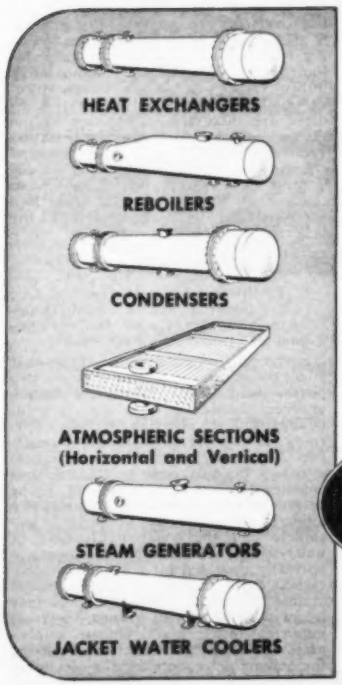
The possibility of reducing coke formation in the catalyst by application of high temperatures and space velocities was investigated. It is known that coke formation decreases with increasing temperature for any given depth of cracking. A laboratory unit was developed that permitted cracking at temperatures up to 700 C., and with contact time as low as ten-thousandths of a second. Feed material was heated in a correspondingly short time, thus minimizing thermal reactions. At 650 C. very low amounts of coke were produced from cumene or from cetane. A large decrease in coke production was obtained from West Texas gas oil at higher temperatures. The space velocity corresponding to a given extent of cracking was found to be affected not only by the increasing rates of cracking at higher temperature, but also by the mesh size of the catalyst particles. The specific effect of particle size indicates that catalytic cracking at lower temperatures is slow relative to the rate of diffusion of the reactants and products in and out of the catalyst. At higher temperatures the cracking reactions become faster than diffusion and therefore take place preferentially in the external layers of the larger catalyst particles. Therefore, for a given temperature, there is a maximum permissible particle size beyond which the most effective utilization of the catalyst surface is not attainable. A bibliography of 11 references is included.

Products: Properties, Utilization And Analysis

Properties of High Boiling Petroleum Products.

W. A. Dietz, W. H. King, Jr., W. Priestley, Jr., and John Rehner, Jr. (Esso Laboratories, Standard Oil Development Co., Linden, N. J.), *Ind. Eng. Chem.* **44** (1952), pp. 1818-27.

Some high boiling products from modern refining processes are carcinogenic with respect to lower animals and it is therefore assumed that they are potentially hazardous to man. The authors report studies of the relationships be-



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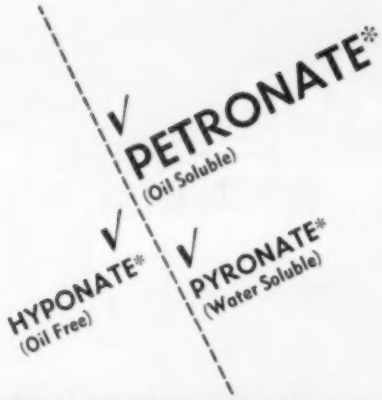

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[Science Abstracts]

tween the tumor-producing capacities of such materials, and some of their physical and chemical properties, and the processes from which they are derived. It was found that high boiling streams from catalytic cracking had high potencies. Fractions boiling above 700 F. are dangerous, while those boiling below that temperature are innocuous. Data are presented to show how the potency of fractions varies with boiling range. The carcinogenic potency is associated entirely with aromatic compounds. Results are also given for innocuous or less potent noncatalytic streams, including virgin gas oils, lubricating oil stocks, tars from thermal cracking, slack waxes, residuums, and also for aromatic extracts, raffinates, and blends of some of these products. Safe disposal of catalytic cycle stocks can be accomplished by recycle catalytic cracking or thermal cracking to reduce the production of catalytic products boiling above 700 F., or by blending to a safe tolerance level with noncarcinogenic refinery streams. A bibliography of 13 references is included.

Classification of Bitumens in Asphalt Technology by Certain Rheological Properties. Part I.

S. L. Neppe, *Jour. Inst. Petroleum* **38** (1952), pp. 109-54.

The author makes a survey of the literature on bitumen viscosity and consistency and includes a comprehensive bibliography of 120 references. The standard ring-and-ball softening point, penetration and ductility test, and the relationships between them are discussed. Graphical representation methods as used by other investigators in relating viscosity to temperature, are examined and improvements are suggested in a number of relationships. The present situation as regards the classification of asphaltic bitumens is summarized. Comparative utility values of various temperature-susceptibility factors and penetration indices are discussed. Anomalies in the present system of standard penetration values are indicated, and a more rational conception of "true penetrations" is advocated as a logical development from the work of Pendleton, which takes into account the shape and dimensions of the penetrometer needle.

Detergents From Petroleum.

S. F. Birch (Anglo-Iranian Oil Co., Ltd., Research Station, Sunbury-on-Thames, England), *Jour. Inst. of Petroleum* **38** (1952), pp. 69-87.

Surface-active agents are those that affect the interfacial tension between two phases such as solid/liquid, liquid/liquid, or even liquid/gas. They include compounds with emulsifying, wetting, softening, penetrating, and detersive properties. The primary action of the detergent is to wet the surface to be cleaned, thus enabling the dirt to be displaced. To be detergent, a compound must contain two kinds of groupings, one lipophilic or oil-soluble and the other hydrophilic or water-soluble. The oil-soluble grouping is normally provided by a straight hydrocarbon chain of eight to sixteen carbon atoms. The water-soluble grouping may be any one of several groups, the most important of which are sulphate, sulphonate, carboxylate, and hydroxyl. Among the anionic detergents are the secondary

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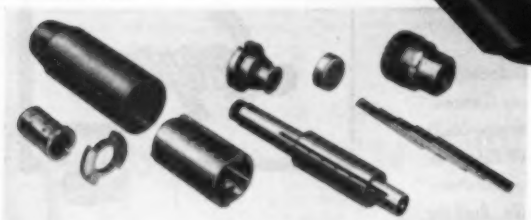

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[Science Abstracts]

alkyl sulphates, the alkane sulphonates and the alkylarylsulphonates. The production of these compounds from petroleum sources is described and discussed. The non-ionic detergents are all derivatives of ethylene oxide. The production and nature of these compounds is briefly described. A bibliography of 19 references is included.

The Deterioration of Transformer Oil. Part I. Operating Difficulties and their Causes.

L. Massey, *Jour. Inst. Petroleum* **38** (1952), pp. 164-71.

The primary purpose of the paper is to discuss some laboratory tests connected with the selection and performance of transformer oil for the information of those not familiar with the engineering aspects of transformer practice. Some remarks are made describing the nature and function of a power transformer and the reasons why oil is used in it. Two principal features are related to the use of oil, namely the presence of high electrical stresses and the development of heat. Oil is an insulator and also a heat transfer medium. Manifestations of deterioration obvious to the operating engineer are related to the chemical factors involved. The requirements for limiting oil deterioration are discussed. The need for accelerated laboratory tests for evaluating the oil and the materials of construction of a transformer are emphasized. A bibliography of six references is given.

The Nature of Soap-thickened Lubricating Greases.

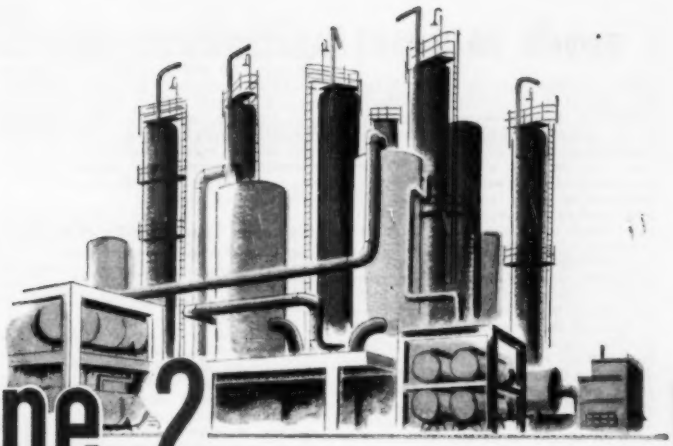
Marjorie J. Vold and Robert D. Vold (Dept. of Chemistry, University of Southern California, Los Angeles, California), *Jour. Inst. Petroleum* **38** (1952), pp. 155-63.

The nature of greases and the service requirements of greases are briefly described and the fundamental problems connected with greases are briefly suggested. Phase diagrams were determined for calcium stearate and its hydrate, and lithium stearate, in cetane and in decalin, and for the system sodium stearate-cetane. It was demonstrated that grease systems of apparently similar phase condition can differ from each other in properties such as X-ray-diffraction pattern, liquid loss under pressure, yield value, effect on rubbing surfaces, etc. This is attributed to the existence of a definite type of organization or structure of the dispersed soap particles, an hypothesis that appears to be confirmed by electron micrographs of greases. A bibliography of 22 references is appended.

Liquid Phase Hydrocarbon Oxidation.

E. R. Booser and M. R. Fenske (The Pennsylvania State College, Pa.), *Ind. Eng. Chem.* **44** (1952), pp. 1850-6.

A study was made of hydrocarbon oxidation as related to the deterioration of lubricating oil and also as related to the mechanism of oxidation. The oxidation characteristics of several pure hydrocarbons typical of the structures believed to be present in higher boiling petroleum fractions were studied. The results of the study of these compounds was compared with those of the study of two hydrocarbon mixtures, a condensed ring aromatic concentrate and a com-



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posite paraffinic neutral and portions of the neutral as separated by silica gel treatment. A wide variation was found in the stability and in the nature of the oxidation products formed from the various hydrocarbon structures. Over a thousandfold difference in stability was observed in going from the least stable hydrocarbon, 1-hexadecene up to the most stable, phenanthrene. The effect of catalysts in the form of metal wire, as well as temperature variations, was studied. In the case of the paraffinic neutral oil the oxidation of the aromatic hydrocarbons in it appeared to predominate in spite of the much lower stability of a naphthene-paraffin concentrate separated by silica gel extraction. The authors observe that the oxidation stability of mixtures of hydrocarbons can seldom be predicted from the characteristics of the components of the mixture. The data secured in the work are presented in detail in tabular and graphical form and a bibliography of 18 references is included.

The Identification of Bitumens by Colorimetric Methods.

D. C. Broome (Fellow) and R. M. Edwards, *Jour. Inst. of Petroleum* **38** (1952), pp. 88-97.

The paper is a summary of the work over a period of years in the practical application of the photoelectric colorimeter for the identification of bitumen present in road and building asphalts. The bitumen portion is dissolved with benzene, and the light-absorption characteristics of the solution are measured photoelectrically over the range of the visible spectrum. The use of the Spekker absorptiometer is recommended. The application of the procedure to various problems connected with the manufacture of asphalt is discussed. The use of the Spekker instrument in the manner described permits a speedy determination of the composition of an asphaltic cement by examination of the complete asphalt mixture. A bibliography of ten references is given.

Oxidation Characteristics of Lubricating Oils at High Temperatures.

H. Diamond, H. C. Kennedy, and R. G. Larsen (Shell Development Co., Emeryville, Calif.), *Ind. Eng. Chem.* **44** (1952), pp. 1834-43.

The object of the investigation was to extend knowledge of oil oxidation up to the highest possible temperatures, that is, temperatures up to the point of ignition, and, from a practical standpoint, to explain the behavior of lubricants in the upper, or hottest part, of the engine. Most previous investigations have been concerned with the performance of oil in the crankcase. The oil was exposed in thin film and since it was not stirred or agitated, diffusion of oxygen and the chemical reaction velocity are both determining factors. The temperature coefficient of the rate of oxidation increases as temperature rises. The metals, copper, iron, and lead, either in metallic or in soluble form, are catalysts of oxidation. In every case, some of the solid metal is dissolved in the oil. It was found that the lowering concentration or depletion of reacting components in the oil is not a significant factor in an experiment of reasonable length. The experimental method used made it possible to study the stability aspect of lubricants under conditions that resemble those prevailing in the power zone of an engine and independently of the detergency aspect and uninfluenced by such factors as fuel and the various mechanical idiosyncrasies of an actual engine. It was found that the behavior under severe conditions is in some, but not all, respects similar to that observed at moderate temperatures.

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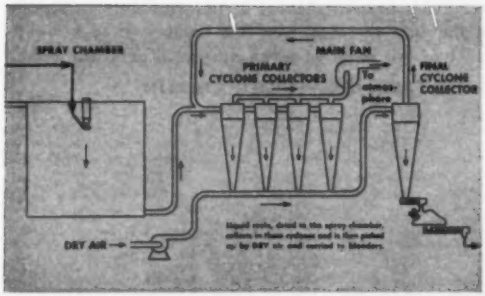

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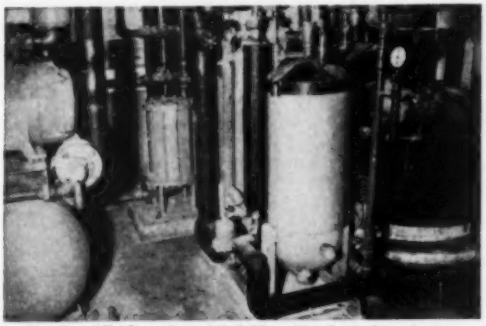

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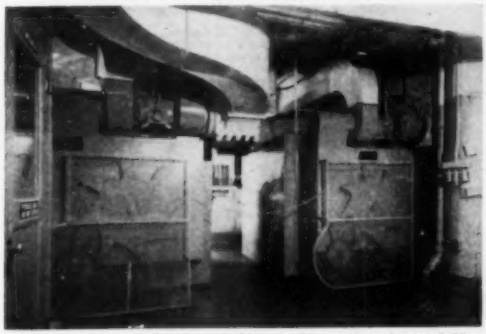
On instrument air at Calco Chemical Division, Willow Island, W. Va.

No moisture gets into air lines here to condense, form ice, rust or sludge and cause trouble. Two Lectrodryers* designed especially for instrument air work, catch the vaporous moisture which aftercoolers, filters and separators let by. Calco Chemical Division's products are consistently higher in quality, therefore.



Aureomycin and penicillin are packed in a sterile area where the air is held at 6% relative humidity by these Lectrodryers.

Holding humidities constant at Lederle Laboratories Div., Pearl River, New York

Control the quality of air surrounding processes, just as you control materials going into products; this is a rule for quality production at Lederle Laboratories Division, as at the other divisions of American Cyanamid Company. Besides sterilizing the air here, Lectrodryers hold it at a constant temperature and humidity.

You probably have plenty of places where Lectrodryers will help you boost quality and speed production. For help in finding out, write Pittsburgh Lectrodryer Corporation, 307 32nd Street, Pittsburgh 30, Pennsylvania.

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* REGISTERED TRADEMARK U.S. PAT. OFF.

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New Catalogs AND EQUIPMENT LITERATURE

For copies of the catalogs and new equipment literature listed, use one of the convenient Reader Service Postcards on this page. Just circle the number on the card corresponding to the number of the item in which you are interested.

Process Pumps

Single-stage vertically split process pumps for handling light refinery liquids at temperatures to 250° F. are described by the Cameron Pump Division of Ingersoll-Rand in a recently issued catalog. The pumps are designed around the use of a Cameron mechanical shaft seal as a solution to the problem of stuffing box leakage and elimination of packing difficulties and maintenance.

Circle No. 1 on Postcard

Semi-Automatic Pipe Cutter

Vernon Tool Company, Ltd., has issued a bulletin which describes the Vernon pipe-cutting pantograph, a unit for making all types of beveled cut-offs used in pipe fabrication work. The pantograph is a semi-automatic guided torch machine that produces straight or beveled cut-offs, saddle and insert type tee intersections, lateral intersections and miters up to 22½°.

Circle No. 2 on Postcard

New Colmonoy Catalog

Wall Colmonoy Corp., has issued a new catalog covering the various hard facing alloys manufactured by them.

Further information about the manual is available upon request.

Circle No. 3 on Postcard

Control Valve Development

"New Techniques in Control Valve Design," a new 16-page technical bulletin announced recently by Conoflow Corporation, describes the development of Conoflow's present day conventional control valves and gives a look-see into the future designs. Illustrated, the bulletin explains the underlying reasons for today's designs and the logic behind the predicted designs for the future.

Circle No. 4 on Postcard

Detection Limits Table

A table of detection limits of more than 20 metals for the Beckman Models B and DU Flame Spectrophotometers has been published by Beckman Instruments, Inc. The sensitivity of the Beckman Spectrophotometers makes possible precision detection, and the new table lists such elements as the most useful wavelengths for flame photometry detection.

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New Catalogs AND EQUIPMENT LITERATURE

Use one of the free and convenient Reader Service Postcards on this page to request copies of the catalogs in which you are interested.

Revised Instruments Bulletin

The application of Speedomax Electronic pH recorders and L&N Electrode Assemblies for the measurement of dehydrator-water pH is now covered in an extensively revised bulletin issued by the Leeds & Northrup Company. Featuring installation pictures and a diagram showing the method of application, both a plastic flow block type of electrode assembly and a Pyrex flow chamber assembly are described and illustrated. The bulletin provides complete specifications and overall dimensions for Speedomax equipment.

Circle No. 6 on Postcard

Explosive Gas Detectors

Four types of combustible gas protective instruments are cataloged in a new folder, Form FSE1251, published by Johnson-Williams, Ltd. Included are a portable Indicator which determines the explosive level of suspected vapor, a portable audible alarm which is used to guard against gas at any location where there is an open flame, and two types of combustible gas alarms which guard against the appearance of explosives in specific areas.

Circle No. 7 on Postcard

Pumps, Repair Parts Catalog

The publication of a new catalog on its line of Tri-Rotor pumps and the establishment of a Tri-Rotor pump repair parts and service center have been announced by the Stamford Division of The Yale & Towne Manufacturing Company.

The catalog contains information on the various models in the Yale & Towne pump line and offers detailed explanations of the operations of the pumps. Information on pump accessories and descriptions of the combinations and permutations which are possible with these accessories. A section is devoted to engineering data helpful in determining the size of pulp to be used and the method of installation.

Circle No. 8 on Postcard

Hydraulic Lift Trucks

Bulletin 525, released by Barrett-Cravens Company, presents hydraulic lift trucks which fit into the current trend to move materials and goods in larger loads. The new Barrett hydraulic lift trucks are designed for the easier and safe one-man handling of heavy skid and box loads. Features include complete hydraulic lifting and lowering, easy travel, from anti-friction bearings and Zerk lubrication; wide spread front wheels for stability; fully enclosed pump and ram; spring handle hold-up to keep handle in safe position; and easily removable hydraulic unit.

Circle No. 9 on Postcard

Wires and Cables

United States Rubber Company, electrical wire and cable department, has published a new, 186-page catalog of its more than 500 different types of wires and cables.

The catalog contains data on construction and operating characteristics for such products as control and signal cables, railroad wire and cables, wire and cables for building industry, telephone wire and cables, mine cables and portable cords. Copies of the catalog are available upon request.

Circle No. 10 on Postcard

(More Literature Items on Pages 193, 196, 197, 199)

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A4	B4	C4	D4	E4	F4	G4	H4	J4	K4	L4	M4	N4	P4	Q4	R4	S4
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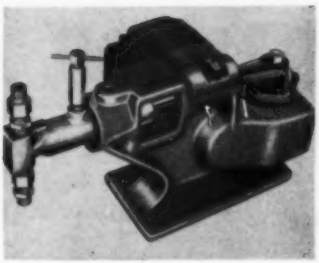


Chemical Solutions Feeder

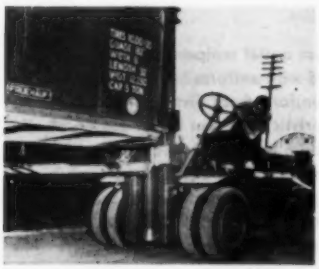
The compact Model X-52 Adjust-O-Feeder is designed to provide accurate feeding of chemical solutions for plants where low capacity and medium pressure will meet requirements. The unit, produced by %Proportioneers, Inc.%, has a built-in oil-enclosed gear reduction and a built-in standard motor. It weighs less than 100 pounds and is ready to operate as soon as wiring and piping connections are made.

(Circle No. 11 on Postcard)

Metal Flexible Couplings

The Thomas Flexible Coupling Company's full line of all metal flexible couplings for power transmission is described in its latest engineering catalog. In the 78-page catalog-binder, couplings are grouped and indexed. Keyway data, standards for straight and tapered bores as well as ordering instructions are included.

(Circle No. 12 on Postcard)



Fork-Lift Truck Attachment

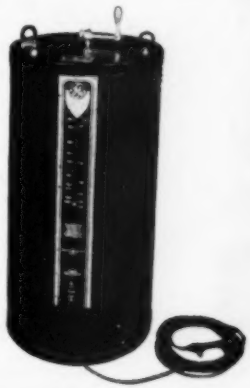
Designed for use on 6000-10,000-pound capacity fork-lift trucks for simple movement of empty semi-trailers, a new attachment has been developed by the Industrial Truck Division of Clark Equipment Company. The device is made to slip over the forks of the lift truck, where it is fastened with a chain. With the new attachment, a trailer may be pushed or pulled to its desired location. Further details are available upon request.

(Circle No. 13 on Postcard)

Steam Trap Catalog

Armstrong Machine Works has recently issued its new "Steam Trap Book," designated as Catalog J and superseding its previous Catalog H. The catalog serves as a manual of recommended trapping practice. The publication includes a trap catalog section containing complete physical data and list prices on Armstrong cast semi-steel and forged steel inverted bucket steam traps and other Armstrong products. A handbook section explaining how to calculate condensate loads and select traps for all classes of equipment and a maintenance section explaining trap installation, preventive maintenance, trouble shooting and repair make-up of the book.

(Circle No. 14 on Postcard)



Hydrogen Transformer Welder

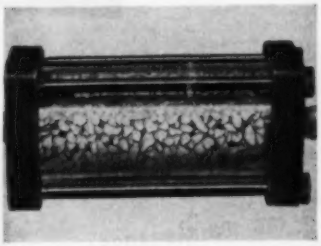
General Electric Company has redesigned its atomic-hydrogen transformer welder, incorporating a new hot-start circuit, silicone insulation, and an extra-wide current range. The 10 to 100 ampere range allows use of one machine on all applications. Silicone insulation insures longer coil life, and faster starting is accorded by the new hot-start circuit. A range switch permits change from one current range to another without moving the welding cable. (The range is divided into two sections, 10 to 35 amps, each extending the length of the indicator scale.) The welder operates on 60 cycles, single phase voltage, with a 75 ampere rating.

(Circle No. 15 on Postcard)

Spectrophotometers

More than 500 specific sources of application data for the Beckman Models B and DU Spectrophotometers are listed in a new bibliography of applications issued by Beckman Instruments, Inc.

(Circle No. 16 on Postcard)



Moisture Indicator

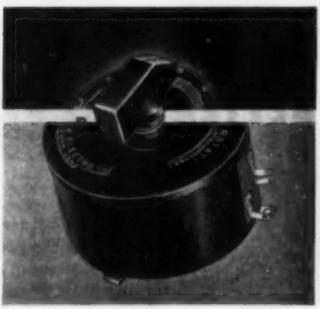
An Air Line Moisture Indicator for use in air or gas lines to give visual indication of the presence or absence of moisture has been developed by King Engineering Corporation. Consisting of a pyrex glass cylinder filled with moisture-sensitive blue granules, the unit has end plates tapped for ¼-inch pipe. In operation, it is placed in a line between the air supply and the point at which the air is used. The granules stay blue as long as the air leaving the Indicator is dry, and turn pink when it contains moisture or water vapor.

(Circle No. 17 on Postcard)

Steel Combination Nipples

LE-HI steel combination nipples made by the new LE-HI process are described in a bulletin issued recently by the Hose Accessories Company.

(Circle No. 18 on Postcard)



Voltage Control Transformer

The Superior Electric Company has announced the addition of Powerstat type 10 variable transformer to its line of voltage control equipment. The new Type 10 is rated at 120 volts, 60 cycles, single phase input with an output of 0-120/132 volts, 1.25 amperes, 150/165 VA. It is designed for 50, 100 and 150 watt applications. Its size permits installation under a three-inch chassis and is designed for single hole mounting with a projection on the base for keying to the panel.

(Circle No. 19 on Postcard)

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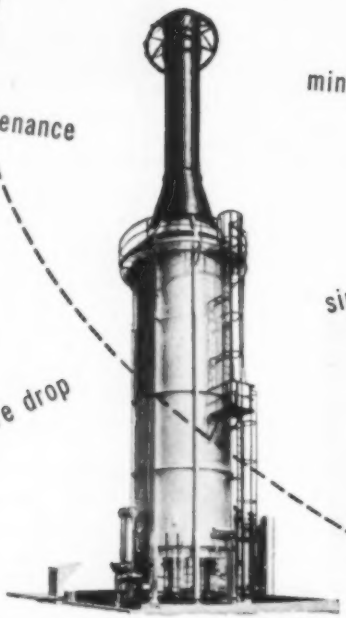

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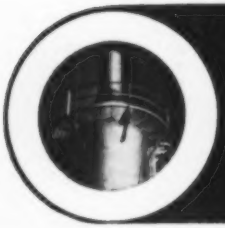

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[What's New in Equipment]

Plant Communication System

Consisting of sound powered telephone handsets, an explosion proof amplifier and explosion proof speakers, the Cal-Alarm, a refinery or chemical plant communication system developed by R. E. Salter, Cal-Alarm Communications, offers private telephone communication, paging service and instrumentation alarm. Complete information is available upon request.

(Circle No. 20 on Postcard)

Inductance Bridge Receiver

A receiver for measurement and control of flow and liquid level has been developed by the industrial division of the Minneapolis-Honeywell Regulator Company which combines in a single instrument functions which formerly required the use of two instruments. The new instrument, an ElectroniK inductance bridge receiver, makes it possible to indicate, record, integrate and control flow and liquid level. Data can also be retransmitted pneumatically to a second receiver remotely located. An Indexet mechanism is available to reset the control index from a remotely located transmitter. Accurate to within plus or minus one-half of one percent of full scale, the instrument combines the inductance bridge transmission system with the Brown Continuous Balance System for power positioning of the pen.

(Circle No. 21 on Postcard)

ISA Training Program

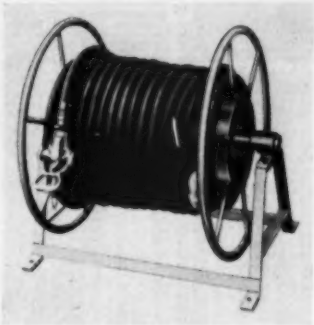
The National Office of Instrument Society of America has released a 60-page outline for the operation of an Instrument Mechanic Training Program. The publication, which is entitled "Industrial Instrument Training Course Outline," covers selection of mechanic personnel, instructor's suggestions, physical equipment, reference books and films, and a detailed outline of training material according to subject.

(Circle No. 22 on Postcard)

Pipe, Bolt Threading Unit

A type of self-contained die head is a new feature on the Rigid "500" pipe and bolt threading machine manufactured by The Ridge Tool Company. The Quadritype die head is adjustable to thread one to two inch pipe, including over and under size. Dual and Monotype die heads also offer this size change in the machine. All tools in the new "500" thread, cut and ream independently and swing up out of the way when not in use. The chuck is Ridgid-built, has six adjusting pinions so one is always in sight. The motor supplies power for pipe up to 12 inches when geared tools are used and is a universal forward-reverse, 115 volts, 25 to 60 cycles, AC or DC single phase. The machine comes in bench and stand models.

(Circle No. 23 on Postcard)



Continuous Flow Hose Reel

A new, continuous flow hose reel for fighting fires instantly and keeping water damage to a minimum has recently been developed by Wirto & Knox Manufacturing Company. With the new reel, time is saved because water pressure is available at the hose nozzle even when the hose is coiled on the reel. A swivel joint connection in the pipe line permits application of a full stream of water on the fire while the hose is being unreeled. This eliminates the time required to turn on the valve after the hose is run out. The rounded surfaces of the reel prevent cutting or other damage to the hose. A universal mounting permits installation on walls, columns, ceilings or floors. A complete range of sizes is available.

(Circle No. 24 on Postcard)

Recorders, Controllers Data

To describe how Speedomax Recorders and Controllers are being applied to a variety of uses in industrial production and research, Leeds & Northrup Company has published a revised edition of its Speedomax catalog, "Speedomax Type G Instruments For Measurement and Control." The publication has been expanded to include numerous installation pictures of Speedomax instruments in plant and laboratory, as well as specifications for the latest additions to the Speedomax line.

To the catalog listing of Speedomax instruments for recording or control of temperature, speed, and power have been added recorders for measuring pH, daylight illumination, electrolytic conductivity, and eight or other mechanical loads.

(Circle No. 25 on Postcard)

New Heat Resisting Fiber

Able to resist temperatures that melt cast iron, yet so fine that it can be used as a superfilter, The Carborundum Company's new material, "Fiberfrax," promises to solve many industrial and defense problems. No critical materials are required in the production equipment of the material, which is the latest product of research at The Carborundum Company.

(Circle No. 26 on Postcard)

Ultrasonic Thickness Testing

The economy, speed and convenience of non-destructive thickness measurements by the ultrasonic Audigage Thickness Tester, manufactured by Branson Instruments, Inc., can be materially increased under awkward conditions by the use of a new magnetic fixture to hold the Searching Unit against the plate being tested. This accessory assures good contact and prevents accidental shifting of the searching unit during tests, and permits one man to operate the instrument alone in different locations.

The fixture consists of a flat spring with an Alnico permanent magnet coupled flexibly to each end, and means for attaching the searching unit quickly and easily to its center. The standard magnets are of sufficient strength to hold the unit properly against surfaces that are slightly irregular or covered with a thin coat of paint; heavier magnets can be provided for use on cast iron and other rough surfaces, or on plates that are covered with thick coatings of paint or scale. The standard fixture is only five inches wide and weighs six ounces.

(Circle No. 27 on Postcard)

Off and On Gas Torch

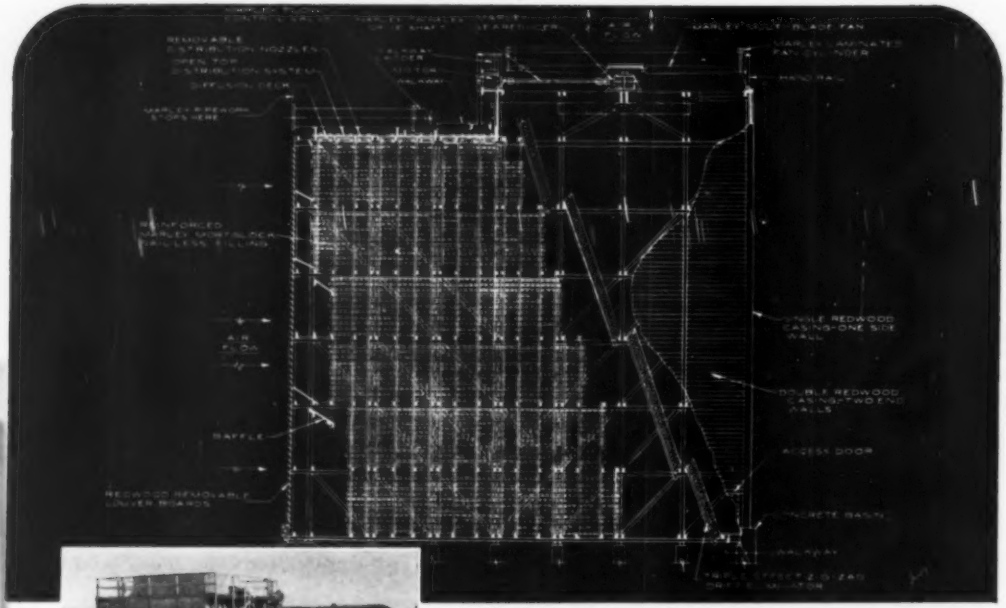
Lighting at the squeeze of a trigger and shutting off on release, the "Torch-O-Matic," an automatic acetylene-air gas torch recently announced by the Velocity Powel Tool Company, is said to be especially well-suited for intermittent work, such as in plumbing, heating, piping, air conditioning, refrigeration and sheet metal jobs. It weighs 12 ounces and provides heat up to 2800°.

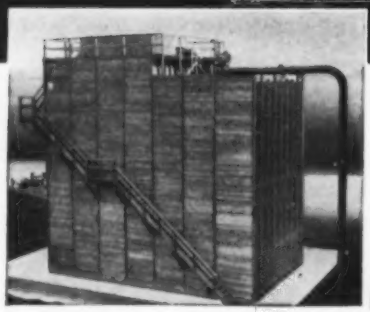
(Circle No. 28 on Postcard)

Efficient Indirect Heaters

Designed to aid in the selection of the most efficient heater for job requirements, a 39-page catalog published by Black, Sivalls & Bryson, Inc., gives a complete description of the company's line of "70" series and "junior" indirect heaters, their uses, advantages, construction, capacities and specifications, dimensional drawings, and standard equipment furnished with each model. This catalog will be furnished free upon request.

(Circle No. 29 on Postcard)





for MAXIMUM PERFORMANCE with NARROW PLAN AREA

Engineers who know, choose MARLEY Single-Flow

SINGLE-FLOW COOLING TOWERS adapt Marley patented cross-flow water cooling to confined areas, retaining the features that have built and maintained Marley leadership in industrial water cooling.

Some of these design features, such as the full-height louvered end-wall and patented Mortis-Locked filling are most fully utilized in Single-Flow design. That means greater air volume, more breakup, longer air-water contact—it means wide cooling range and close approach to wet bulb temperature.

Open, visible distribution with its many operational advantages is included in Single-Flow engineering. All mechanical equipment is Marley designed and Marley manufactured for cooling tower use exclusively.

The rugged structural strength and long-tested durability that characterize all Marley design are engineered into every Single-Flow tower. Ease of maintenance and safety of operation are functional features of these high performance towers.

Marley Application Engineers, located in fifty leading cities, will gladly give you further information on Single-Flow cooling towers.

producers of

DOUBLE-FLOW TOWERS
AQUATOWERS
DOUBLE-FLOW AQUATOWERS
DRICOOLERS
NATURAL DRAFT TOWERS
CONVENTIONAL TOWERS
SPRAY NOZZLES

MARLEY

The Marley Company, Inc.

KANSAS CITY 5, MISSOURI

[What's New in Equipment]

Angle Adapter for Riveting

Huck Manufacturing Company has announced a new Angle Adapter which expands the scope of blind riveting to additional assembly and maintenance applications. This Angle Adapter, when used in conjunction with either a Huck Hand Riveting Tool or an Air Riveting Tool, simplifies assembly of previously inaccessible deep channels, hard to reach corners and otherwise difficult-to-rivet locations. One person from one side of work can drive Huck ⅛, 5/32 and 3/16-inch diameter Self Plugging or Pull Through Blind Rivets in a clearance space of four inches from the nose of the riveting tool to the back face of the Angle Adapter. The Adapter fits onto a Huck No. 93 Air Riveting Tool or a No. 94 Hand Riveting Tool.

(Circle No. 30 on Postcard)

Lightweight Fire Shield

A lightweight fire shield, made of glass fiber insulation, has been developed by Gustin-Bacon Manufacturing Company, enabling firefighters to approach within a few feet of a fire with effective protection against radiant heat. Weighing only 26 pounds, the shield can be carried by one man on the run over ditches or rough ground. The user maintains vision through a "peep hole" at eye level. His face is shielded by copper wire that disseminates and dissapates heat. A self sealing opening for hose nozzle is easily cut through the shield wherever desired.

(Circle No. 31 on Postcard)

Teamwork for Oil Products

Produced by the Alco Products Division, American Locomotive Company, "The Alco Products Story," a new 15-minute, 16 mm industrial film, demonstrates engineering and production teamwork in all stages of manufacture of products for oil, chemical and power industries. The movie describes how products are developed and how facilities, machines and manpower are coordinated for efficient output. Prints of the film are available to business groups and professional engineering societies upon request.

(Circle No. 32 on Postcard)

Electronic Trouble Spotter

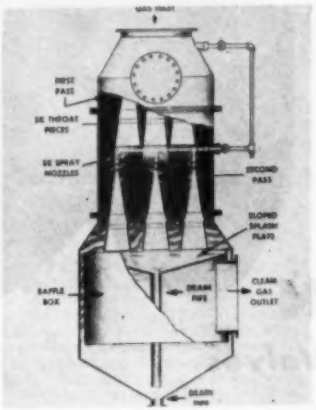
Erwood, Inc., claims its Electro-Probe makes it possible to locate and diagnose developing trouble spots in apparatus, motors and machines while they are in operation before a failure occurs. Incorporating a pick-up probe and three-stage amplifier, the Electro-Probe is unaffected by air-borne noises, being sensitive only to vibrations at the point of contact. Speaker and headphones provide audible comparison of vibration sounds within a range of 60 decibels. A calibrated meter provides visual indication. The probe operates on 36 watt, 110-120 volt, AC 60 cycle current.

(Circle No. 33 on Postcard)

Extruded Plastic Packing

A new, extruded Teflon Plastic Packing, designed for difficult packing applications, has been introduced by the Flexrock Company. It has proven successful in centrifugal pumps handling acids, caustics and hard-to-handle solvents, operating at varying speeds from low rpm to 3500 rpm and higher, according to the manufacturer. Called Teflon Plastic Packing No. 403, the new product is composed of shredded Teflon, Blue Asbestos, combined with suitable binders and lubricants, extruded into an open cotton yarn jacket.

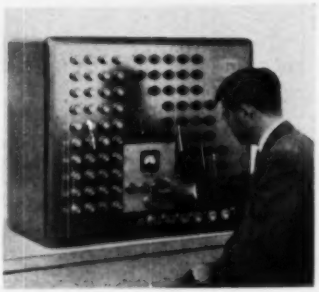
(Circle No. 34 on Postcard)



Gas Scrubber Unit

High scrubbing efficiency and low maintenance are outstanding features of the "Packaged" gas scrubber unit, manufactured by Schutte and Koerting Company. The unit will handle gas containing wettable solids and condensable gases as well as gases and solids which can be cleaned by obtaining a chemical reaction between the gas or solids and selected spray liquid. Units can be constructed with as many banks as necessary. Foam surge will not choke the unit and the unit can be arranged for vertical down-flow or for horizontal operation.

(Circle No. 35 on Postcard)



Phase Equilibrium Computer

Beckman Instruments, Inc., is now producing the Beckman Phase Equilibrium Computer for vapor-liquid calculations, permitting technically trained personnel to solve a much greater volume of vapor-liquid relationships than by conventional methods. The manufacturers claim that non-technical operators can solve complex phase equilibrium equations in three to four minutes, as compared with as much as one and one-half hours required by trained personnel using conventional trial and error calculating procedures. Operation is simple. The data, consisting of analyses of the feed, together with equilibrium constants for the given temperatures and pressures, is set into the machine by means of numbered decade dials. A few dials are adjusted to balance the network, as indicated on a null-indicating meter, and the ratio of total liquid to total vapor is solved. Complete information is available upon request.

(Circle No. 36 on Postcard)

Laboratory Equipment

Technical Equipment Company is introducing to the market an extensive line of petroleum products testing laboratory equipment, and has prepared a brochure listing materials currently available. All equipment has been designed to conform to relevant American Society for Testing Materials and Federal specification. The company offers to modify the standard design of all equipment to conform to material and design changes desired by the customer or to custom design and build equipment for non-standard tests.

(Circle No. 37 on Postcard)

Piping Requirements Today

The Pipe Fabrication Institute has announced publication of "End Preparation and Internal Machining for Machined Backing Rings for Butt Welds," a standards bulletin superseding the first standards bulletin issued by the institute four years ago. This revised standard meets present-day high-pressure and high-temperature piping requirements and includes design changes that minimize the amount of weld metal required and the resultant shrinkage stresses in the weld.

(Circle No. 38 on Postcard)

How to Work at

FULL TILT

and lose less than ever!

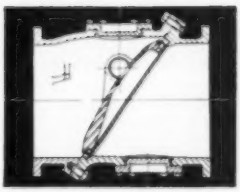
INSTALL

CHAPMAN

Tilting-Disc Check Valves

Take another look at the diagram below. That tilting disc actually *balances as it closes* . . . so that it cushions itself into a drop-tight seat . . . without any slamming under usual piping arrangements.

This means far lower head loss than with other types of check valves. It means, too, far lower rate of wear of moving parts . . . for the disc is the *only* moving part. In fact, it means more savings and less trouble than you ever knew you could get with *any* check valve. Write for Catalog No. 30, giving complete test results at some of the country's leading engineering laboratories.



Cross-section of the Chapman Tilting-Disc Check Valve. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

THE CHAPMAN VALVE MFG. CO.
INDIAN ORCHARD, MASSACHUSETTS

[What's New in Equipment]

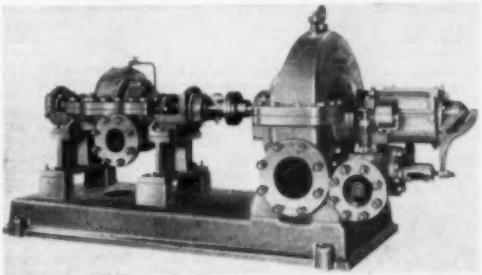
New Nagle Catalog

A new 36-page catalog describing the complete Nagle line of pumps has been offered by Nagle, Pumps, Inc. Also included in the catalog are types TW and AW which are recent additions to the Nagle line.

(Circle No 39 on Postcard)

Increased HP Steam Turbines

The Dean Hill Pump Company has announced a horsepower step-up in their DH line of steam turbines. Formerly these turbines developed 500 horsepower with pressures up to 600 pounds per square inch at 700° F. Now they are capable of developing 1000 horsepower with pressures up to 875 pounds per square inch at 750° F. DH steam turbines are single stage impulse, double impact type and is adapted for mechanical drives with pumps, fans, blowers, stokers, generators, line shafts, cane shredders, pulverizers and other plant auxiliaries.



(Circle No. 40 on Postcard)

Improved Titration Unit

Fisher Scientific Company has announced the development of a new improved Titrimeter for the quantitative determination of solutions, micro-titrations and Karl Fisher moisture determinations. This new electronic instrument features a new stand, improved stirrer and control box. In the control unit are combined the means for amplifying the electrical potentials picked up at the electrodes and the means for detecting these changes via the end-point indicator eye. A special micro-titration accessory kit to adapt the improved titrimeter for micro work includes a micro glass electrode, a micro calomel electrode, a micro electrode holder, a micro stirring magnet sealed in polyethylene, a micro burette and a 10-ml sample beaker. Complete descriptive literature is available.

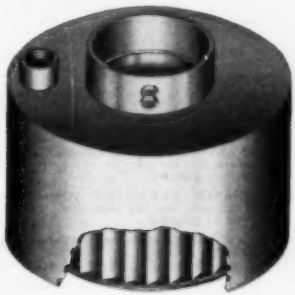
(Circle No. 41 on Postcard)

Caustic Soda Booklet

A newly revised booklet describing all phases of caustic soda is now available from the Dow Chemical Company. More specifically, the booklet deals with the manufacture of caustic soda; chemical and physical properties; economics involved; methods of handling and storing; technical data; methods of analysis; and first aid treatment for caustic burns.

(Circle No. 42 on Postcard)

Internal Downflow Purifier



Dirt, moisture, riser discharge and solids are removed before passing on to the distribution piping when this new internal downflow purifier is installed in an auxiliary tank immediately above evaporators, packed towers, deodorizers, stills, bubblecap towers and inside steam drums, flash tanks, receivers and other vessels. Called Internal Downflow Purifiers and manufactured by The V. D. Anderson Company, they serve numerous functions, depending upon the application. They increase heating efficiency and protect pipeline equipment in steam application. In chemical and petroleum vessels they recover valuable vapors. Removal of foreign matter is accomplished by means of a multi-stage centrifugal element which engages the entrainment laden vapor at the inlet at the top of the purifier as far away from the liquid level in the drum as possible. Made in fabricated steel, stainless steel or other alloy materials in outlet sizes of four inches to 224 inches furnished with slip joint connections or can be threaded in sizes four inches through 10 inches.

(Circle No. 43 on Postcard)

Solenoid Control Units

This new electro-mechanical device, employing dual oil damped solenoids, that produces a smooth, quiet and hand-like motion should be of interest to the design engineer of petroleum equipment. Designed by Scully Machine Company to meet the stringent requirements for maximum power per unit size, coupled with a smooth stroke cycle that would produce equal power and an equal time cycle for two-way and centering positions, the unit employs a dual oil damped solenoid with a rocker arm connecting the plungers. Cam operated micro-switches are used to enable the opposite solenoid to be energized after the work stroke has been completed. The oil damped dual solenoid units are adaptable for applications requiring quiet cusioned motion with moderate power requirements.

Two models have been introduced: an open unit, and a totally enclosed oil filled unit. The latter is completely sealed and utilizes neoprene oil seal gaskets for the cam shaft, and may be mounted in any position. The open unit is furnished with open wells and must be mounted horizontally. A complete descriptive brochure on the units is available, including schematic drawings and power curves.

(Circle No. 44 on Postcard)

Cat Cracking History

A decade of historical engineering developments in Fluid catalytic cracking from the first units at Baton Rouge, La., to the most modern Orthoflow converters are discussed in the current issue of the KELLOGGRAM, published by the M. W. Kellogg Company. In addition to discussing Fluid catalytic cracking in general, the issue also describes the new Orthoflow converter, a Kellogg development.

(Circle No. 45 on Postcard)

Hydraulic Tools

The "Idea Book," a job-picture book showing how hydraulic tools can solve production, construction, maintenance and other problems, is published by Blackhawk Manufacturing Company.

(Circle No. 46 on Postcard)

Catalogs AND EQUIPMENT Literature OFFERED IN THIS ISSUE'S ADVERTISEMENTS

Copies may be obtained easily and without cost by using Reader Service Postcard. Just circle on the card the identifying key number of each item in which you are interested. Postcards are opposite page 320.

TUBE CLEANERS—Details. Airetool Manufacturing Co. See page 188.
Circle A1 on postcard.

STEEL FLOOR PLATE—Folder S-52. Alan Wood Steel Co. See page 178.
Circle A2 on postcard.

AIRCOOLERS—Bulletin. Alco Products Division, American Locomotive Co. See page 15.
Circle A3 on postcard.

EXPLOSION-PROOF MOTORS—Bulletins 51B7149 and 51B7286. Allis-Chalmers Manufacturing Co. See page 5.
Circle A4 on postcard.

HEAT EXCHANGER TUBES—Booklet. Aluminum Company of America. See page 218.
Circle A6 on postcard.

CATALYTIC REFORMING PROCESS—Information. The Atlantic Refining Co. See pages 6-7.
Circle A8 on postcard.

REFRACTORY CASTABLE—Bulletin R-22. The Babcock & Wilcox Co. See page 217.
Circle B1 on postcard.

STEEL GRATING—Bulletin 2365. Blaw-Knox Co. See page 208.
Circle B10 on postcard.

ELECTRONIC RECORDER—Catalog P1245. The Bristol Co. See page 19.
Circle C2 on postcard.

HEAT EXCHANGERS—Bulletin 481. The Brown Fintube Co. See page 206.
Circle C4 on postcard.

CENTRIFUGAL COMPRESSORS—Book. Carrier Corp. See page 42.
Circle C6 on postcard.

CHECK VALVES—Catalog No. 30. The Chapman Valve Mfg. Co. See page 198.
Circle C8 on postcard.

ALUMINUM WEATHERPROOF JACKETING—Sample. Childers Manufacturing Co. See page 30.
Circle D2 on postcard.

REGULATING VALVES—Information. The Clark Manufacturing Co. See page 216.
Circle D4 on postcard.

CENTRIFUGAL BLOWERS—Bulletin 0500. De Laval Steam Turbine Co. See page 51.
Circle E3 on postcard.

HANDLING MATERIAL EQUIPMENT—Information. Dempster Brothers, Inc. See page 163.
Circle E4 on postcard.

CENTRIFUGAL CASTINGS—Catalog 3150. The Duraloy Co. See page 180.
Circle E8 on postcard.

INSULATION PRODUCTS—Technical Data. The Eagle-Picher Co. See page 226.
Circle E9 on postcard.

STAINLESS AND HIGH ALLOY PRODUCTS—Catalog. Electric Steel Foundry. See page 79.
Circle E10 on postcard.

TUBE CLEANERS—Bulletin V-29. Elliott Co. See page 155.
Circle F2 on postcard.

GRAPHIC PANEL INSTRUMENTS—Bulletin 463. The Foxboro Co. See page 18.
Circle F8 on postcard.

MECHANICAL-DRIVE TURBINES—Bulletin GEA-4955A. General Electric Co. See pages 20-21.
Circle F10 on postcard.

AIR-COOLED EXCHANGERS—Information. The Griscom-Russell Co. See page 88.
Circle G2 on postcard.

COOLING-TOWER FANS—Information. Hartzell Propeller Fan Co. See page 240.
Circle G4 on postcard.

PROPORTIONING PUMPS—Catalog UP-52. Hills-McCanna Co. See page 239.
Circle G5 on postcard.

DIFFERENTIAL RELAY—Bulletin. Instruments, Inc. See page 232.
Circle G8 on postcard.

WIRE MESH PRODUCTS—Details. The C. O. Jelliff Mfg. Corp. See page 190.
Circle H2 on postcard.

HEAT INSULATION—Information. Kaylo Division. See page 50.
Circle H5 on postcard.

CORRUGATED ASBESTOS-CEMENT SHEETS—Details. Keasbey & Mattison Co. See page 95.
Circle H6 on postcard.

GRATING AND STAIR TREADS—Catalogs. Klemp Metal Grating Corp. See page 212.
Circle H8 on postcard.

RECORDERS AND CONTROLLERS—Information. Leeds & Northrup Co. See page 8.
Circle J2 on postcard.

SEPARATOR-FILTER-AIR ELIMINATOR—Bulletin FEQ-51. Warner Lewis Co. See page 211.
Circle J3 on postcard.

SWING JOINTS—Information. A. Y. McDonald Mfg. Co. See IV Cover.
Circle J8 on postcard.

CONTROL VALVES—Bulletin 700-2. Minneapolis-Honeywell Regulator Co. See page 57.
Circle K2 on postcard.

MIXING EQUIPMENT—Literature. Mixing Equipment Co. See page 75.
Circle K3 on postcard.

STEAM TURBINES—Information. Murray Iron Works Co. See page 209.
Circle K6 on postcard.

GROUND ANODES AND BACKFILL MATERIAL—Catalog Section S-6510. National Carbon Co. See page 176.
Circle K5 on postcard.

TRAPS, VALVES & FLOATS—Catalog 751. W. H. Nicholson & Co. See page 31.
Circle K7 on postcard.

MAINTENANCE CLEANING JOBS—Booklet. Oakite Products, Inc. See page 210.
Circle K8 on postcard.

WELDED CARBON TUBING—Bulletin. Pacific Tube Co. See page 39.
Circle L2 on postcard.

PROCESS PUMPS—Bulletin B-1605. Peerless Pump Division. See page 33.
Circle L4 on postcard.

GAGES, PUMPS AND EJECTORS—Bulletins 5030, 512, 4929 and 35. Penberthy Injector Co. See page 52.
Circle L5 on postcard.

CORRUGATED FLEXIBLE TUBING—Folder. Pennsylvania Flexible Metallic Tubing Co., Inc. See page 170.
Circle L6 on postcard.

WELDED ALLOY EQUIPMENT—Catalog. The Pressed Steel Co. See page 40.
Circle M1 on postcard.

GATE VALVE—Information. Reading, Pratt & Cady Division. See page 184.
Circle M2 on postcard.

CONDENSER TUBES—Booklet. Revere Copper & Brass Inc. See page 151.
Circle M6 on postcard.

INSULATED PIPE LINES—Literature. The Ric-Wil Co. See page 182.
Circle M7 on postcard.

DIAL THERMOMETERS—Details. Rochester Manufacturing Co. See page 225.
Circle M9 on postcard.

BALL VALVES—Bulletin. Rockwood Sprinkler Co. See page 24.
Circle N2 on postcard.

POSITIVE DISPLACEMENT METERS—Bulletin 40-B-14. Roots-Connersville Blower Corp. See page 162.
Circle N3 on postcard.

CONDENSER TUBES—Booklet. Scovill Manufacturing Co. See page 14.
Circle N4 on postcard.

GRADIATION HEATERS—Booklet. Selas Corporation of America. See page 80.
Circle N5 on postcard.

PUMP VALVES—Catalog. Sims Pump Valve Co., Inc. See page 220.
Circle N9 on postcard.

CRANE CARRIERS—Information. Six Wheels, Inc. See page 169.
Circle N10 on postcard.

PETROLEUM SULFONATES—Booklet. L. Sonneborn Sons, Inc. See page 186.
Circle P1 on postcard.

PROPORTIONING PUMPS AND DIAPHRAGM VALVES—Catalogs UP-52 and V-52. The Edward Soph Co. See page 239.
Circle P2 on postcard.

FIRED HEATERS—Bulletin B-45. Struthers Wells Corp. See page 55.
Circle P4 on postcard.

SKID MOUNTED GASOLINE PLANT—Information. Superior Manufacturing Co. See page 214.
Circle P6 on postcard.

INHIBITOR-SWEETENING PROCESS—Information. Tennessee Eastman Co. See page 189.
Circle P8 on postcard.

MULTISTAGE TURBINES—Bulletin S-146. The Terry Steam Turbine Co. See page opp. 97.
Circle P9 on postcard.

COATING COMPOUNDS—Catalog 50. Tnemec Company, Inc. See page opp. 64.
Circle Q2 on postcard.

DESALTING PROCESS — Information. Tretolite Co. See page 53.
Circle Q3 on postcard.

INSULATION MATERIAL—Bulletin 76-109. Union Asbestos & Rubber Co. See page 62.
Circle Q4 on postcard.

CHEMISEAL PACKINGS—Catalog. United States Gasket Co. See page 235.
Circle Q5 on postcard.

SHELL AND TUBE HEAT EXCHANGERS—Bulletin HE-6. Henry Vogt Machine Co. See page 46.
Circle Q9 on postcard.

PROCESS VALVES—Bulletin 698. W-K-M Company. See page 47.
Circle R1 on postcard.

IRON VALVES AND PIPE FITTINGS—Information. Walworth Co. See page 9.
Circle R3 on postcard.

METAL THERMOMETERS—Literature. Weston Electrical Instrument Corp. See page 171.
Circle R5 on postcard.

VERTICAL TURBINES—Information. Whiton Machine Co. See page 227.
Circle R6 on postcard.

TUBE CLEANERS AND EXPANDERS—Literature. Thomas C. Wilson, Inc. See page 233.
Circle R7 on postcard.

STEAM TURBINES—Bulletin 1966. Worthington Corp. See page 10.
Circle R9 on postcard.

PROCESS PUMPS—Bulletin V-341-B14. Worthington Corp. See page 11.
Circle R10 on postcard.

STEAM TRAPS—Selector. Yarnall-Waring Co. See II Cover.
Circle S2 on postcard.

EXPANSION JOINTS AND FLEXIBLE COUPLINGS—Catalog 47 and Bulletin 351. Zallea Brothers. See page 25.
Circle S3 on postcard.

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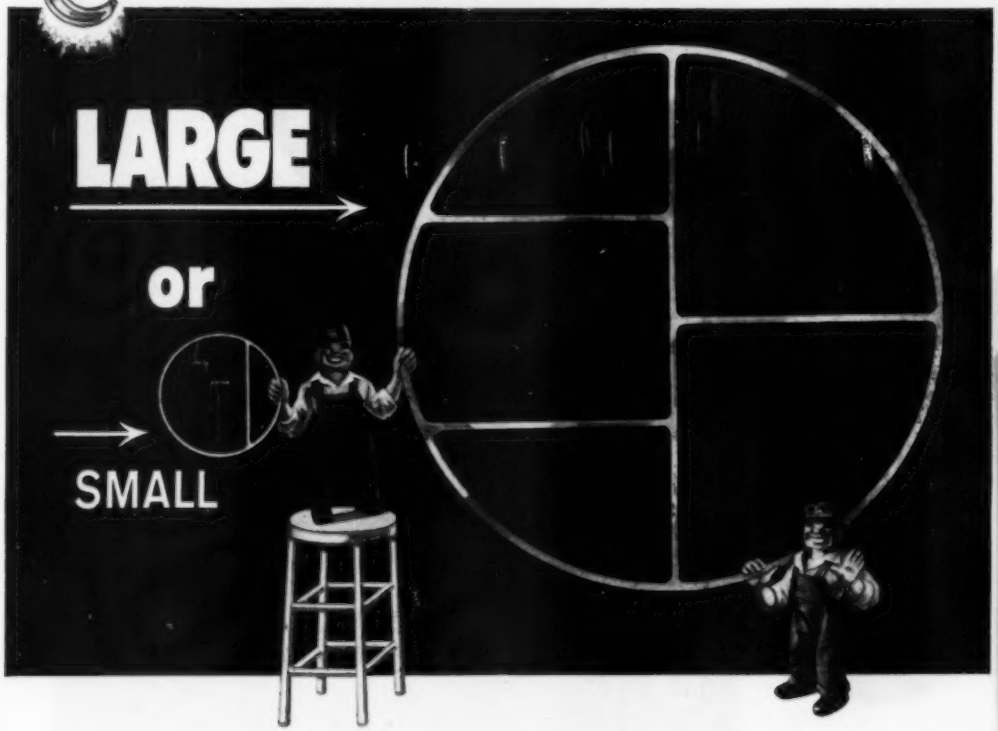

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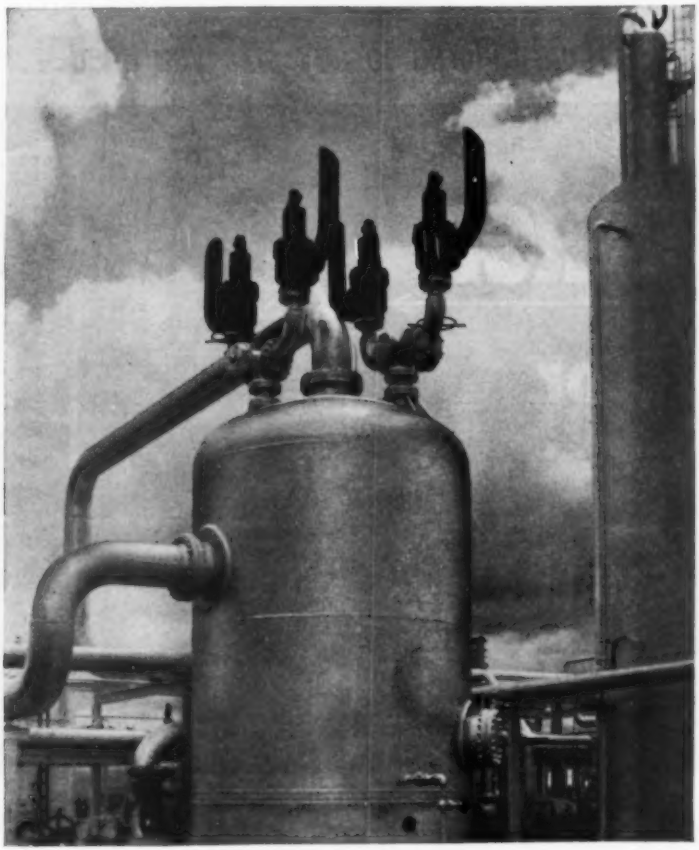
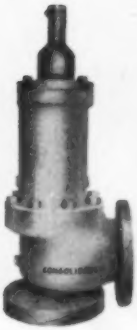


Consolidated Safety Relief Valves installed on main scrubber at Stanolind Oil & Gas Co., Stano, Kansas.



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[New Patents Affecting Petroleum Refining]

Dr. Heinz Heinemann
Compiled from U. S. Official Gazette July 29, August 5, 12, 19 and 26, 1952

Refining

Methods for the Acid Refining of Hydrocarbons. G. W. Edwards to Soc. Anon. Francaise pour la Separation, l'Emulsion et le Melange, Paris.

In the refining of hydrocarbons with concentrated sulfuric acid, one of these two components is atomized and caused to impinge at a relatively high speed into a thin layer of the other component. The proportion of acid to hydrocarbon shall exactly correspond to that required for saturating the unsaturated components of the hydrocarbon mixture. U.S.P. 2,605,213.

Process for Breaking Petroleum Emulsions. M. DeGrote to Petrolite Corporation, Ltd.

Petroleum emulsions of the water-in-oil type are broken by means of a demulsifier including hydrophile synthetic products of certain complex combinations. U.S.P. 2,605,230-3.

Separation of Oxygen-Containing Organic Compounds from Aqueous Mixtures. F. H. Brunner, H. V. Hess, and G. B. Arnold to The Texas Company.

The non-acidic aliphatic water-soluble oxygenates of a Fischer-Tropsch synthesis containing up to eight C atoms are separated from acidic aliphatic water-soluble oxygenates also formed, by countercurrently contacting their mixture with a hydrocarbon solvent at a temperature of 175-300 F. under pressure sufficient to maintain liquid phase conditions. An extract and a raffinate phase are formed thereby and are separated. U.S.P. 2,605,276.

Refining of Shale Oil. J. R. Smith and G. U. Dinneen to the U. S. Secretary of the Interior.

Shale oil containing 10-60 percent by weight of organic nitrogen compounds and substantial amounts of olefinic and aromatic hydrocarbons is contacted with magnesium silicate to adsorb the major portion of the nitrogen compounds. The non-adsorbed portion of the shale oil is recovered. U. S. P. 2,606,143.

Method of Removing Inhibitors for Urea Adduct Formation. W. S. Higley, W. J. Zimmerschied, and A. P. Lien to Standard Oil Company (Indiana).

Straight-chain hydrocarbons are separated from a mixture thereof with non-straight-chain hydrocarbons and an inhibitor for urea-adduct formation, such as an aromatic polycyclic sulfur compound, by contact with a solid adsorbent or a strong inorganic acid, such as liquid anhydrous HF, to remove said sulfur compound. The resulting fraction is contacted with urea under suitable conditions in the presence of water. The adduct of urea and straight-chain hydrocarbons is then withdrawn and decomposed. U.S.P. 2,606,214.

Propane Fractionation of Reduced Crude Oil with Recycle of Heavier Bottoms. B. C. Benedict to Phillips Petroleum Company.

A lubricating oil stock from low asphalt-content reduced crude lubricating oil stocks is fractionated with liquid propane under high pressure and at relatively high temperature without the formation of hard asphaltic deposits. Details are claimed. U.S.P. 2,606,859.

Continuous Separation of Hydrocarbons with Cuprous Halide Absorbents. S. P. Robinson to Phillips Petroleum Company.

Unsaturated hydrocarbons containing not more than five C atoms are separated from a gaseous mixture containing them together with close boiling more saturated hydrocarbons by absorbing the unsaturates in finely divided solid cuprous halide. The rich absorbent is suspended in a heated stream of stripped product gas to effect desorption. U.S.P. 2,606,938.

Process of Separating Vinyl Xylenes from Ethyl Xylenes and Other Products. W. E. Elwell and H. L. Childress, Jr., to California Research Corporation.

A mixture of ethyl and vinyl xylene and higher boiling products is distilled with steam in a first zone under reduced pressure in the presence of elemental sulfur to inhibit polymerization of the vinyl xylene. Ethyl xylene is separated overhead. The bottoms is subjected to a second distillation under similar conditions with the introduction of two-fifth parts by weight of steam per part of hydrocarbon to separate vinyl xylene as overhead. U.S.P. 2,607,720.

Method of Separating Light Hydrocarbon from High-Pressure Gas. D. T. McDonald, Jr., and T. H. King to Socony-Vacuum Oil Company, Inc.

A hydrocarbon gas mixture is treated with an absorption oil in several steps to separate therefrom a heavy gas fraction and to recover at the pressure of the hydrocarbon gas mixture a residue gas fraction. Details of the process are claimed. U.S.P. 2,608,270.

Color Stable Gasoline Composition. B. R. Strickland to Standard Oil Development Company.

A paraffinic base gasoline composition contains 0-4.6 ml. per gallon of tetraethyl lead, 1-1½ theories of a halogenated hydrocarbon lead, based on tetraethyl lead, and certain amounts of N, N'-di-sec-butyl-p-phenylenediamine and cyclohexylamine. The first of these two additives works as an antioxidant and the second as a color stabilizer. U.S.P. 2,608,476.

Combination High and Low Pressure Absorption Process. A. J. Miller to Phillips Petroleum Company.

A process is claimed of treating a raw wet natural gas containing propane and heavier constituents to transfer such gaseous constituents from a low pressure to a high pressure residue gas stream without compressing as a gas said gaseous constituents. This is done by a plurality of consecutive absorption steps with the use of a lean absorption oil. U.S.P. 2,608,516.

Process for the Production of High-Quality Heating Oils. E. J. Niehaus, Jr., and H. F. Whitney, Jr., to Standard Oil Development Company.

Virgin petroleum oil boiling in the heating oil range is first contacted with a relatively weak NaOH solution and thereafter with oxygen and a relatively strong NaOH solution at a temperature of 105-160 F. The thus treated oil is contacted with water, whereupon a high-quality oil of low mercaptan content is obtained. U.S.P. 2,608,522.

Process for Utilizing Prepared Oil-Bearing Material as a Filtering Agent in Solvent Extraction by Continuous Countercurrent Flow. M. Bonotto, Princeton, New Jersey.

Granulated pieces of a material obtained from the minute particles remaining in screening flaked solvent-extractable oil-bearing material are employed as a filtering material in the extraction of this oil-bearing material. U.S.P. 2,608,565.

Catalyst Preparation, Activation and Regeneration

Process for Regeneration of Spent Doctor Solutions. R. M. Love to Standard Oil Development Company.

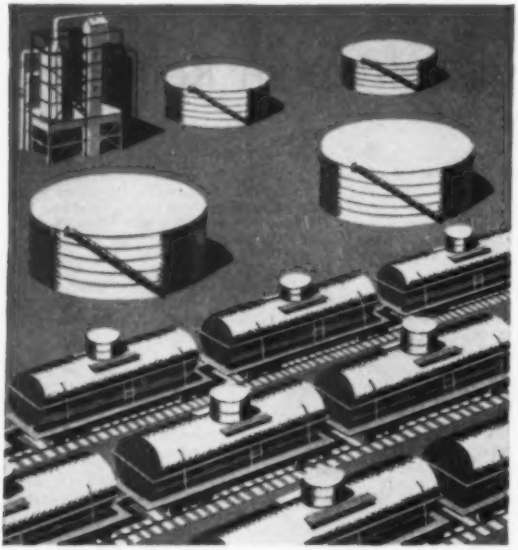
Alkali metal plumbite solutions spent in the sweetening of mercaptan-bearing oils are regenerated by the addition of a liquid hydrocarbon phase comprising a major portion of aromatic hydrocarbon in an amount sufficient to dissolve all polymers and gums formed therein. The mixture is contacted with free oxygen. Regenerated plumbite solution is recovered. U.S.P. 2,605,165.

Recovering Antimony Trichloride from Hydrocarbon Extract Phase. J. F. Deters to Standard Oil Company (Indiana).

Antimony trichloride used for the extraction of hydrocarbon oil is recovered from the extract phase formed by adding to this extract 10-15 percent benzene (based on the weight of $SbCl_3$ in the extract). Antimony trichloride crystallizes out and is separated. U.S.P. 2,605,211.

Regeneration of a Carbonized Fischer-Tropsch Catalyst. A. H. Friedman to Phillips Petroleum Company.

Spent finely divided Fischer-Tropsch metallic catalyst is suspended as a



More Octane Barrels

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GASOLINE	B/D	RVP	BON*	B/D	RVP	BON*	B/D	RVP	BON*
STRAIGHT RUN AND THERMAL	10,000	77.0	68	10,000	7.0	68.0	10,000	7.0	68
REFORMED NAPHTHA	1,792	5.0	84.1	1,790	5.0	84.2	1,873	5.0	82.6
CAT-GASOLINE	6,700	4.9	90.5	6,620	7.0	91.5	6,300	7.0	92.5
POLYMER	950	2.5	110	950	2.5	110	950	2.5	110
BUTANE	1,384	68.0	105	1,137	68.0	105	1,127	68.0	105
BLEND	20,826	10.0	81.0	20,497	10.0	81.0	20,250	10.0	81.0

*Blending Octane Number (Research Method)

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fluidized mass in a gas inert to the carbon deposited on the catalyst at the prevailing temperature. The carbon deposit is abraded by the contact of the catalyst particles with each other. The abraded carbon is removed in the effluent gas stream from the thus reactivated catalyst. U.S.P. 2,605,234.

Reactivation of an Alumina-Metal Oxide Catalyst. E. W. Pitzer to Phillips Petroleum Company.

Spent catalyst comprising alumina and a difficult-to-reduce heavy metal oxide is digested in finely comminuted state with a mixture of NH_4NO_3 and HNO_3 to extract at least a portion of the said metal oxide. The resulting mixture is dried and then heated to convert any metal nitrate formed to the oxide. U.S.P. 2,605,235.

Silica-Magnesia Catalyst for Hydrocarbon-Oil Conversion. G. M. Webb to Standard Oil Company (Indiana).

An improved silica-magnesia catalyst of stable activity and regenerability in the conversion of hydrocarbon oils consists of a homogeneous, porous mixture of catalytically inactive silica with up to 25 percent MgO in the form of catalytically active magnesium silicate. U.S.P. 2,605,237.

Coprecipitated Silver-Beryllium Oxide Catalyst. G. W. Sears, Jr., to E. I. du Pont de Nemours & Company, Inc.

A catalyst adapted to catalyze the oxidation of ethylene to ethylene oxide is obtained by coprecipitating a reducible oxygen-containing silver compound and a corresponding beryllium compound in an Ag:Be weight ratio of from 10:1 to 5000:1 from a solution containing compounds of both metals. The coprecipitate is reduced to a mixture of metallic silver and beryllium oxide. U.S.P. 2,605,239.

Silver-Beryllium Oxide Catalyst and Method of Making Same. G. W. Sears, Jr., and W. W. Thompson to E. I. du Pont de Nemours & Company, Inc.

The subject of this patent is closely related to that of U.S.P. 2,605,239. The ratio of Ag:Be employed here is from 5:1 to 150:1. The coprecipitate formed is further treated here in a special manner to eventually obtain a mixture in which the Ag:Be ratio is from 100:1 to 500:1. U.S.P. 2,605,240.

Process for the Production and Recovery of Organic Peroxides. A. E. Robertson and A. R. Jones to Standard Oil Development Company.

A straight run hydrocarbon fraction boiling in the 80-190 C. range is oxidized in the liquid phase with air at a temperature of 115-165 C. The resulting mixed stream of hydrocarbons and organic peroxides is continuously passed into a silica gel adsorption zone to adsorb the peroxides. The enriched adsorbent is desorbed with acetone to recover the peroxides formed. The residual petroleum fraction from the adsorption step is recycled to the oxidation step, and the silica gel is reactivated by steam. U.S.P. 2,605,290.

Regeneration of Alkaline Solutions Used in the Removal of Sulfur Con-

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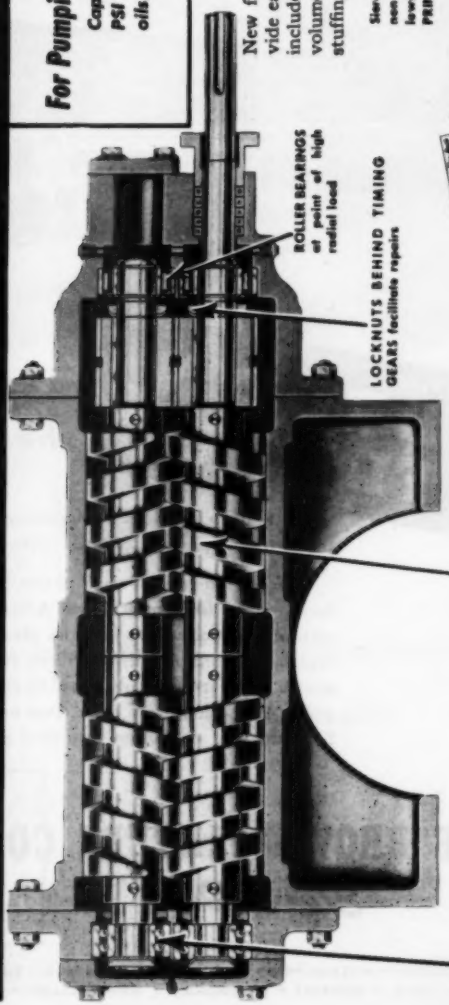

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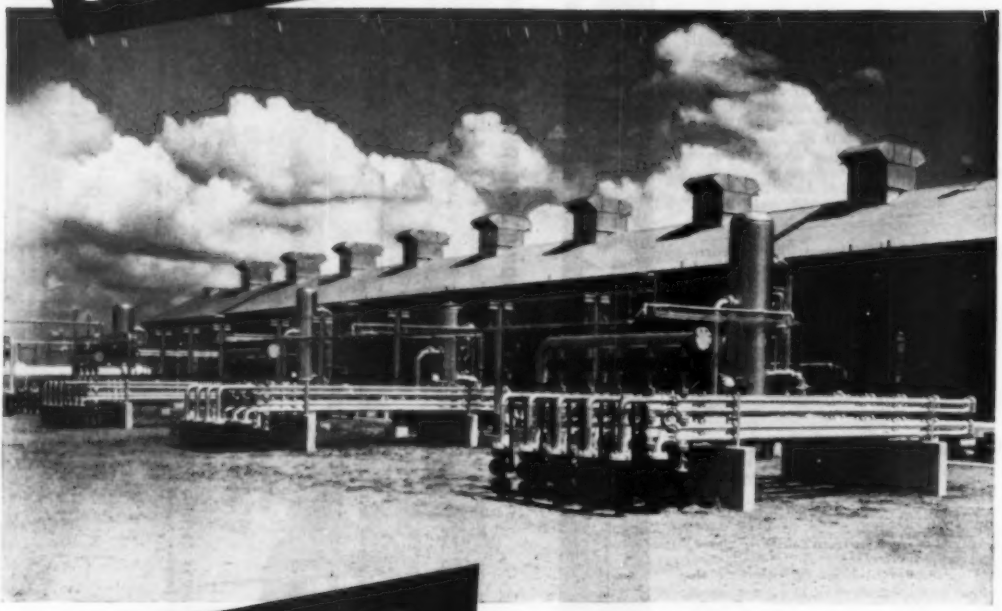

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taminants from Hydrocarbon Oils. J. H. Brooklyn and S. P. Comley to Socony-Vacuum Oil Company, Inc.

An alkaline solution used to extract mercaptans from hydrocarbons and containing a small amount of a catalytic oxidation promoter, such as pyrogallol, is contacted with an oxidizing gas containing free oxygen for such a time that the mercaptides are oxidized to an extent that only a small portion thereof remains, sufficient to reduce any portion of the pyrogallol or other promoter that may become oxidized. U.S.P. 2,606,099.

Depth-Controlled Impregnation of Alumina-Base Catalyst Pellets. J. R. Owen to Phillips Petroleum Company.

Particulate alumina is mixed with a combustible binder. The mixture is formed into pellets. 15-85 percent of the binder is removed by combustion so as to form a porous shell surrounding a relatively impervious core in each pellet. The porous shells are impregnated with an aqueous solution of a metal compound converted to the oxide upon subsequent calcination. The remaining portion of the binder is burnt out in this calcination. U.S.P. 2,606,159.

Silver-Silver Oxide Catalyst on Fused Beryllia. R. L. Heider to Monsanto Chemical Company.

A catalyst useful in the oxidation of ethylene to ethylene oxide consists of silver, silver oxide, or mixtures thereof deposited upon a carrier composed of fused beryllium oxide particles. U.S.P. 2,606,160.

Process of Reacting an Organic Compound of Aluminum and/or Magnesium with a Group IV Halide to Form a Catalyst. J. P. West to Universal Oil Products Company.

A hydrocarbon conversion catalyst is prepared by effecting a metathesis reaction between a halide of group IV of the periodic table in which the halogen radical has an atomic weight greater than 19 and at least one metal salt of Mg and/or Al fatty acid, or such compounds of aliphatic alcohols or phenols, at a temperature of at least 150 C. but below the normal decomposition temperature of the metal salt. U.S.P. 2,606,877.

Double-Calcination Process of Preparing an Alumina-Platinum-Halogen Catalyst. V. Haensel to Universal Oil Products Company.

Precipitated alumina is calcined and mixed with a chloroplatinic acid-ammonium hydroxide solution in an amount of 0.01-1 percent by weight of platinum. Thereafter, aqueous HF is mixed with the alumina in an amount to form a final catalyst containing 0.1-3 percent of fluorine by weight of the alumina on a dry basis. The resultant composite is heated. U.S.P. 2,606,878.

Stripper for Subdivided Catalyst Particles. L. C. Huff to Universal Oil Products Company.

An apparatus is claimed for stripping fluidized hydrocarbon conversion catalysts. U.S.P. 2,607,662.

Catalyst Unit. W. A. Perry and D. R. Merrill to Rohm & Haas Company.

A catalytic unit comprises a plurality of layers of catalytically active metal gauze in intimate contact with each other. Further details of construction are claimed. U.S.P. 2,607,663.

Heteropoly Acids or Salts Thereof as Catalysts. R. N. Fleck to Union Oil Company of California.

A catalyst for hydrocarbon conversions consists of inorganic metal oxides or hydroxides as a carrier material, impregnated with 3-20 percent of a heteropoly acid salt of Zn, Fe, Co, or Ni. Phosphomolybdic and silicomolybdic acid are the preferred heteropoly acids to be employed. U.S.P. 2,608,534.

Carbon-Containing Fischer-Tropsch Catalyst and Its Preparation. B. G. Gillespie to Standard Oil Development Company.

A Fischer-Tropsch synthesis catalyst consists of sintered iron obtained by reduction of iron oxide intimately mixed with two-ten percent of finely divided carbon particles and a small amount of an alkali metal compound promoter. U.S.P. 2,608,535.

Removal of Carbon from Hydrocarbon Synthesis Catalyst. C. E. Hemminger to Standard Oil Development Company.

For reactivating fluidized catalyst particles in a hydrocarbon synthesis process, the catalyst withdrawn from the dense fluidized bed in the reaction zone is charged to an elutriation zone. A gasiform material is flowed upwardly in this zone in obstructed paths and at a rate such as to effect a separation of the catalyst particles according to their content in carbon; those particles hav-

ing higher percentages of deposits concentrating in the upper portion of the elutriation zone while those with a lesser amount of deposit concentrate in the lower portion of this zone. A fraction of the latter particles is returned to the reaction zone. U.S.P. 2,608,569.

Reactivation of Cuprous Oxide Oxidation Catalysts. K. D. Detling and T. Skei to Shell Development Company.

In the continuous partial oxidation of olefins with at least three C atoms by molecular oxygen in the presence of a cuprous oxide catalyst, the flow of oxygen to the catalyst is discontinued for a brief interval of time when the activity of the catalyst has considerably decreased, while the other conditions are maintained unchanged, whereupon the flow of oxygen is restored. U.S.P. 2,608,585.

Cracking and Refining

Catalytic Cracking of Nitrogen-Containing Oils. L. S. Galstaun to Tide Water Associated Oil Company.

In the catalytic cracking of hydrocarbon oil containing nitrogen compounds which tend to poison the catalyst, the oil is contacted in the liquid phase under non-cracking conditions with catalyst of relatively low cracking activity for a time sufficient to adsorb on this catalyst at least a part of the nitrogen content of the oil. The resulting mixture of liquid oil and catalyst is then contacted under cracking conditions with heated catalyst of higher cracking activity. U.S.P. 2,605,214.

Hydrocarbon Conversion Process. S. C. Eastwood to Socony-Vacuum Oil Company, Inc.

High boiling liquid hydrocarbons are converted to lower boiling ones with the use of a compact bed of granular heat carrying material which is moved downwardly by withdrawing a stream of this material from the lower section of the reaction zone while charge stock is introduced into this bed at an intermediate level along its length to effect a partial conversion of the liquid hydrocarbons to a gasiform product containing lower boiling hydrocarbons. More details are claimed. U.S.P. 2,606,861.

Particle Contacting Apparatus. J. H. Stephens to Universal Oil Products Company.

The construction is claimed of an apparatus for contacting fluidized catalytic material in conversion processes, such as the cracking of hydrocarbons, which have an endothermic reaction and an exothermic regeneration zone. The former is arranged inside the latter. U.S.P. 2,608,473.

Production of Fuel Gas by Cracking Propane. L. W. Pollock to Phillips Petroleum Company.

In the continuous cracking of hydrocarbon gases rich in propane to produce a fuel gas, hot pebbles are employed gravitating in a compact bed through the reaction zone. A mixture of propane and steam is fed to the reaction zone under specific conditions of temperature, pressure and reaction period. The steam removes a substantial portion of the carbon normally deposited in the reaction zone. U.S.P. 2,608,478.

Catalytic Cracking of Hydrocarbons with a Silica-Alumina-Zirconia Composite. C. L. Thomas to Universal Oil Products Company.

Ordinarily liquid hydrocarbon fractions are cracked in the presence of a catalyst prepared by calcining a mixture of silica and alumina obtained by subjecting a zeolite to mild treatment with acid and freeing the same of alkali metal. Zirconia can also be contained in the mixture. The zeolite is obtained by drying a mixture of hydrous oxides and alkali cation. U.S.P. 2,608,525.

Polymerization And Conversion

Conversion of Heavy Carbonaceous Oils to Motor Fuels, Fuel Gas, and Synthesis Gas. C. A. Coghlan to The Texas Company.

Details are claimed for a process for converting heavy hydrocarbons to lighter ones, fuel gas and hydrogen-containing gas. The oil is dispersed in the form of droplets into the top of the reaction zone into contact with an upwardly flowing stream of hot gases comprising CO and H_2 at a temperature of 800-1500 F. Free flowing particles of coke are formed from the downwardly moving volatilized droplets and are subjected to further treatment, while a vaporous effluent of hydrocarbon vapors and gases is discharged from the upper portion of the reaction zone. U.S.P. 2,605,215.

Process for the Preparation of Acetylenic Compounds. P. J. Garner and D. A. Firth to Shell Development Company.

An alkyne-1 hydrocarbon containing at least three C atoms, such as heptyne-1, is reacted with an alkali metal in the presence of 10-50 percent by weight of heptyne-2 or another corresponding alkyne-2 compound in a liquid medium, such as xylene, in which the resulting alkali metal acetylide is soluble. This solvent shall contain 0.05-0.5 percent by weight of S or Se in the form of a compound thereof. U.S.P. 2,605,295.

Fluid Type Catalytic Reaction Chamber and Method of Operating Same. L. B. Goodson and J. A. Guyer to Phillips Petroleum Company.

A fluid type reaction chamber is constructed in such a manner that finely divided solid catalyst material and a stream of gases or vapors may be intimately contacted therein and that, thereafter, the catalyst may be easily separated from these gases or vapors and recycled with additional gases or vapors. U.S.P. 2,606,097.

Fluidized Conversion and Coking of Heavy Petroleums. F. W. Leffer to Universal Oil Products Company.

Details are claimed of a process for the conversion and coking of heavy hydrocarbon stocks in a fluidized particle bed serving at the same time the effective performance of the conversion and coking reactions and the continuous segregation of relatively fine solid particles desired as nuclei for coke

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NEWS

October ★ One of a Series of Interest to the Petroleum Industry ★ 1952

"An atmosphere that sustains individual achievement"

The future of the nation's scientific advancement will depend on "an atmosphere that sustains individual achievement," Crawford H. Greenewalt, Du Pont president, said recently at ceremonies observing the 50th anniversary of the establishment of the company's explosives laboratory at Gibbstown, N. J.

"I have no doubt that our laboratories can achieve in the next 50 years results which will make contributions of the past 50 seem elementary," he said. "But we must have a system which recognizes individual effort and provides rewards, rather than penalties, for accomplishment.

"Pioneers of 1902 had the determination to show that creative thought applied to industrial problems could produce many products and improve processes for the betterment of mankind." In spite of America's tremendous investment in research facilities, "research is not dollars," he said; "it is an environment in which individual initiative can be most effective. Even the Soviets," he noted, "have found it necessary to provide incentives of various sorts if their research is to make progress."

College Engineering Professors Get Practical Experience At Du Pont

Early last year, Du Pont invited a group of engineering educators to spend one year in the company's engineering department. The professors were not given direct job assignments, but worked on a schedule taking them throughout the entire Du Pont engineering organization.

To make possible this "Year-In-Industry" program, the Du Pont Company assumed the regular salaries and normal expenses of the educators.

Dean David L. Arm of the School of Engineering at the University of Delaware was the first to complete the program. Describing the benefits resulting from it in an article in the Journal of Engineering Education, Dean Arm said, "Through an interchange of information, both industry and engineering colleges better understand each other's problem; it should make for educational programs better suited to the needs of industry; it should result in better counseling of students; it enables the individual who participates to observe at first hand engineering in action; and it creates good public relations both for industry and for engineering education.

"The greatest benefits are long-range and perhaps can never be subject to complete evaluation. It seems logical to assume, however, that as more engineering college administrative officers take advantage of such opportunities, the benefits will increase accordingly. All industry will then be supplied with better trained graduate engineers because of better policies, methods, and philosophies adopted by the engineering colleges.

"Since the benefits of such a program accrue to all industrial companies," he said, "other progressive organizations might well consider similar plans."

Du Pont "Brand Name" Presentation Helps Oil Companies Build Up One Of Their Most Valuable Assets

No one likes to be called "fellow," "guy," or "hey you." If anyone should happen to call *you* by one of these inadequate titles, you would probably be offended.

It follows that, because of your reputation, you are proud of your name. It distinguishes you from the crowd. It stands for the things you stand for. Naturally, therefore, you want people to use your name whenever they refer to you. And the same is true of your company and of your products.

BY GRAPHICALLY ILLUSTRATING the quality factors that influence the performance of your gasoline, the Du Pont brand name presentation helps dealers to think of and talk about these factors as distinguishing features of your own brand.

WHAT'S IN A NAME?

A company's name is one of its most valuable assets. It represents more than producing wells and refineries and offices. It also represents a vast number of people whose individual skills are coordinated to build certain distinct qualities into the products you sell. And it represents, to the buying public, your reputation for producing dependable products.

It is because of this reputation that your company prospers in our highly competitive sys-

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED *Brand Name*

tem. That's why it's so important to make the most of *your* company name and brand name.

REASON FOR BUYING

Too many motorists form the habit of using general terms when referring to gasolines . . . such as "Regular," "High Test," or "Premium." And unless you encourage motorists to use your brand name instead of these general terms, you may be allowing them to think of *your brand* of regular or premium as being identical to all other regular and premium gasolines.

By making every motorist conscious of your brand name—and of the qualities the name stands for—you are supplying him with a yardstick for comparison . . . with a definite *reason for choosing your brand* in a competitive market.

A MENTAL PICTURE

To illustrate this point, let's take the familiar example of automobile names. When the name of a certain make of car is mentioned, you immediately have a mental picture of the car. This picture is more than a vague idea of wheels, engine, and body. It is vivid because the name suggests to you innumerable distinctive details about the car—its lines, speed, cost, etc.

EACH DISPLAY is built progressively by the speaker on a large flannel board. When pressed with the hand, the velvet-like backing on the individual cards sticks readily to the flannel surface.

Gasoline, however, presents a somewhat more difficult problem because it's harder for the driver to visualize its qualities. Yet, by educating motorists in regard to the qualities for which your gasoline is noted, you can stimulate them to associate these qualities with your brand.

GETTING DEALER COOPERATION

To help you increase the importance of brand names as a selling force, Du Pont has developed a presentation designed to stimulate dealers to promote *your* brand names more aggressively.

The presentation is worked up progressively on a large flannel board. It illustrates graphically *all* the various factors which contribute to gasoline quality and performance . . . such as high volatility for quick starting and fast warm up, as well as octane numbers and fast acceleration. It shows, too, how the various hydrocarbons are blended to provide balanced performance. And it explains how these qualities are built into your own gasoline brand through catalytic and thermal cracking and polymerization, as well as by the addition of tetraethyl lead.

PERSONALIZED SERVICE

Du Pont is prepared to make up a brand name presentation for any oil company desiring it.

And each is tailor-made to the individual requirements of the oil company requesting it. It is designed to stress any or all of the specific qualities of the company's brand that the company may desire.

In addition, Du Pont will also be glad to design an individualized booklet to go with the presentation. These can be given out to be taken home by each dealer seeing the presentation, thereby making the brand name message all the more penetrating and memorable.

If you would like to have Du Pont make up an individualized brand name presentation for your company, or would like further information on these presentations, get in touch with your Du Pont representative or the nearest Du Pont district office.

To Work With Refiners On Automotive Combustion Problems

JOHN D. ROGERS

John D. Rogers joined the Du Pont Company in 1951 as a senior engineer at the Petroleum Laboratory. In July of this year he was transferred to the Petroleum Chemicals Division technical group as an automotive technologist.

Before coming to Du Pont, Rogers was engaged in fuel development work for the Standard Oil Company of California, specializing in rocket and jet aviation fuels. Previous to this, he was employed by Wright Aeronautical Corporation as a combustion analyst and design engineer on B-29 engines.

After receiving his B.S. degree in mechanical engineering from the University of Delaware, Rogers was an instructor at Yale where he specialized in internal combustion engines. He received his Masters degree in mechanical engineering at Stevens Institute of Technology and did advance study in thermodynamics at the University of California at Berkeley.

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A-4120

Printed in U. S. A.

deposition from coarse particles desired as a product of the process. U.S.P. 2,606,144.

Interpolymers of Styrene with Styrene-Butadiene Copolymers. E. D. Morris and G. A. Griess to The Dow Chemical Company.

Styrene is interpolymerized with an unsaturated rubbery polymer of an aliphatic conjugated diolefin having 4-6 C atoms. Details of the process are claimed. U.S.P. 2,606,163.

Emulsion Polymerization Using Ultrasonic Vibrations to Effect Emulsification. I. M. Kolthoff and C. W. Carr to Phillips Petroleum Company.

In the emulsion polymerization of a major amount of a conjugated diolefin, the mixture of this diolefin, an aqueous solution of an emulsifier, and a polymerization catalyst is subjected to ultrasonic vibration in the range of 20-500 kilocycles per second. The intensity and period of this treatment shall be sufficient only to transform the mixture into a stable emulsion, which is then subjected to polymerization. U.S.P. 2,606,174.

Alkali Sulfate Salts of Ethylene Oxide Condensation Products as Emulsifiers for Styrene Polymerization. M. Kosmin to Monsanto Chemical Company.

In the emulsion polymerization of styrene, the alkali metal sulfate salt of a condensation product of higher aliphatic alcohols with ethylene oxide is employed as the emulsifier. U.S.P. 2,606,178.

Process for the Polymerization of Ethylene in the Liquid Phase with "Alfin" Catalysts. T. Boyd to Monsanto Chemical Company.

Ethylene is polymerized in the liquid state at temperatures of —80 to 9 C. and pressures of 10-55 atm. in the presence of a catalyst consisting of a mixture of sodium alkenyl derived from an aliphatic olefin and a sodium alkoxide derived from a methyl alkyl carbinol. U.S.P. 2,606,179.

Conversion of Hydrocarbons with the Use of a Hydrogen Fluoride Composite Catalyst. J. E. Penick to Socony-Vacuum Oil Company, Inc.

A mixture of normally liquid hydrocarbons, e.g. naphtha, is converted into a liquid product having a 90 percent point below the 10 percent point of said mixture. The hydrocarbon mixture is contacted for two-five minutes with a catalyst consisting of not more than 10 percent water, 4-10 percent HF-soluble oil, and the balance HF, in the ratio of 0.25-2.0 volumes of the catalyst per volume of the hydrocarbon mixture, at a temperature of 200-470 F. and a pressure at least 150 psi. greater than the vapor pressure of the reaction mixture. The desired product is recovered in a yield of at least 75 percent from the resulting hydrocarbon phase. U.S.P. 2,606,860.

Catalytic Conversion of Hydrocarbons in the Presence of Regeneration Gases. P. C. Keith to Hydrocarbon Research, Inc.

A process is claimed of treating hydrocarbons by passage through a mass of catalyst. The carbonaceous matter deposited on the catalyst during this passage is periodically removed by regenerating gas introduced into the catalyst mass maintained at a pressure of 200-800 psig. The regenerating gas shall consist of steam and oxygen of at least 90 percent by volume purity in molar proportions of 3:1 to 7:1. The regeneration is effected at a temperature of 1600-2500 F. and the regeneration product consists predominantly of H_2 and CO. This product gas is then flowed through the mass in countercurrent direction to the regenerating gas. The hydrocarbons are simultaneously injected into the product gas at a point intermediate the ends of the mass. A temperature of 800-1050 F. and a hydrogen partial pressure of 100-200 psi. are maintained in the resulting mixture of product gas and hydrocarbons in the conversion zone, from which this mixture is withdrawn. U.S.P. 2,606,862.

Process and Apparatus for the Conversion of Hydrocarbons and the Stripping of Vaporizable Hydrocarbons from the Fouled Catalyst. C. A. Rehbein to Shell Development Company.

Hydrocarbon vapors are continuously passed under reaction, e.g. cracking, conditions upwardly through a bed of finely divided fluidized catalyst. Fresh catalyst is continuously introduced into this bed to cause the catalyst to overflow and spill from the top of the bed into a stripping zone. A stripping gas is continuously introduced at a low point into this zone. Catalyst is continuously withdrawn in the fluidized state from the bottom of this zone. The upper level of the fluidized catalyst in this zone is below the level of the fluidized bed of the reaction zone. U.S.P. 2,606,863.

[Patents]

Emulsion Polymerization of Vinylidene Compounds in the Presence of Hydrazine-Alkylenepolyamine Compositions. W. B. Reynolds, J. E. Wicklatz and T. J. Kennedy to Phillips Petroleum Company.

In the emulsion polymerization of a $CH_2{=}C<$ compound alone or together with a conjugated diene with 4-6 C atoms, an oxidant-reductant combination comprising an organic peroxide and a mixture of alkylenepolyamine and hydrazine is used as the catalyst. U.S.P. 2,606,893.

Conversion of Olefins, Carbon Monoxide, and Hydrogen. B. L. Evering and E. F. Peters to Standard Oil Company (Indiana).

A feed stock comprising an olefin, such as ethylene, propylene, or n-butene, and 5-40 percent by volume of a mixture of H_2 and CO in a mole ratio of H_2:CO between 0.5 and 10 is contacted with an alkali promoted iron catalyst at a temperature of 350-425 C. and a pressure of 250-1500 psig. A hydrocarbon is obtained which contains more C atoms than the olefin of the feed. U.S.P. 2,606,939.

Catalytic Polymerization of Olefins. G. C. Bailey and J. A. Reid to Phillips Petroleum Company.

Normally gaseous olefin, e.g. ethylene, is contacted under polymerization conditions with a catalyst consisting of a minor proportion of nickel oxide dispersed on a major proportion of silica

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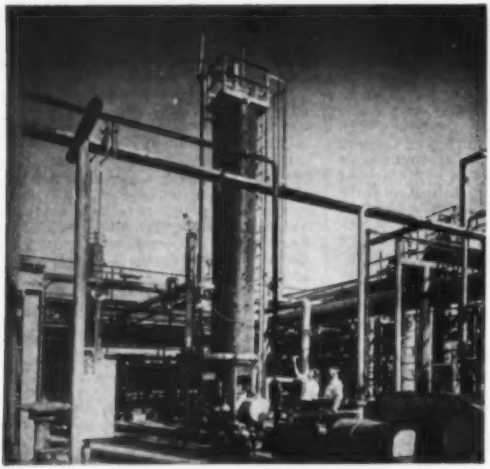

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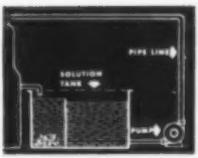

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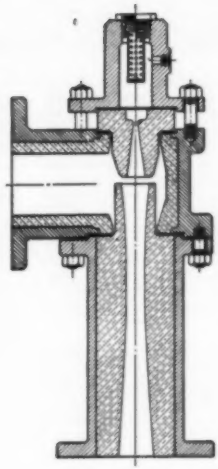

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gel containing 0.1-10 of alumina as a promoter. The catalyst has been activated by heating in an oxidizing atmosphere. A polymerized higher mole weight aliphatic olefin is recovered as the product of the process. U.S.P. 2,606,940.

Method of Separating Isobutylene Polymers from Reaction Mixtures. H. G. Hipkin, H. B. Horwitz and A. G. Rogers to Standard Oil Development Company.

Isobutylene is polymerized at temperatures below —20 F. in the presence of a volatile inert solvent by a Friedel-Crafts polymerization catalyst to form resinous rubbery polymers. In order to vaporize the solvent, the cold mixture of polymer and solvent is rapidly passed through an atomizing nozzle by means of atomizing steam directly into a flowing stream of hot water. U.S.P. 2,607,763.

Vulvanizable Copolymers of Isobutylene and 10-70 Percent Combined Butadiene. J. F. Nelson and L. M. Welch to Standard Oil Development Company.

A mixture of 71-91 percent by weight of butadiene and 29-9 percent of isobutylene is cooled to a temperature of —40 to —164 C. The mixture is then polymerized to at least 20 percent conversion based on the total isobutylene by means of a Friedel-Crafts metal halide catalyst dissolved in a low-freezing, non-complex-forming solvent, such as methyl chloride. U.S.P. 2,607,764.

Conversion of Hydrocarbon Oil to Diesel Fuel and Carbon Black. C. J. Helmers and E. V. Mathy to Phillips Petroleum Company.

High boiling hydrocarbon oils are converted into high cetane number diesel fuel and a stock suitable for the manufacture of carbon black, simultaneously, by separating from the crude oil a naphtha fraction boiling at 350-500 F. and a gas oil fraction boiling above 500 F. The gas oil fraction is cracked in the presence of a bauxite catalyst under special conditions and the resulting product is further cracked thermally. The gas oil thus obtained is extracted with furfural. The raffinate, lean in aromatics, is distilled and mixed with the first mentioned naphtha fraction to form the diesel fuel desired, while the highly aromatic extract oil is employed for producing carbon black. U.S.P. 2,608,470.

Apparatus for Contacting Gaseous Fluids with Powdered Solids. A. S. Gilliam to Shell Development Company.

A vertically disposed apparatus for contacting a gaseous fluid with a finely divided solid catalyst has a conical bottom closure and a gas distribution grid horizontally disposed at the top of this closure part. The gas to be treated entering this closure part below the grid is distributed in that part by a plurality of open ended gas directing radially arranged conduits. U.S.P. 2,608,474.

Apparatus for Use in Converting Hydrocarbons. E. W. Shand to Sinclair Refining Company.

An apparatus for converting hydrocarbons in the presence of spheroidal catalyst pellets of uniform size has a plurality of horizontally extending and vertically spaced tray-like shallow chambers whose widths are many times their heights, and the inlet ends of which are connected with the pellet feeder. These chambers form restricted passages for maintaining a free rolling catalyst bed at single pellet thickness. The hydrocarbon vapor to be treated flows concurrently with the pellets and causes them to roll through the chambers. U.S.P. 2,608,475.

Coking of Carbonaceous Fuel. W. A. Rex to Standard Oil Development Company.

Details are claimed of a process for producing volatile fuels from liquid or solid carbonizable fuels, such as heavy oil residues, asphalts, oil shale and the like, with simultaneous production of coke. The charge material is contacted at elevated temperature with a fluidized mass of heated solids. U.S.P. 2,608,526.

Temperature Control in Shock-Chilling Petroleum Vapor Phase Conversion Products. W. W. Holland to The Gyro Process Company.

In the vapor phase conversion of hydrocarbons, preferably at a temperature of 1000-1550 F., the converted hydrocarbons are sprayed with a cool hydrocarbon quenching medium to reduce the temperature to a reaction-arresting degree, e.g. 600 F. This arresting temperature is maintained constant by continuously controlling the quantity of quenching medium to be sprayed. U.S.P. 2,608,527.

Hydrogenation, Dehydrogenation, Aromatization

Synthesis Gas Manufacture. J. C. Krejci to Phillips Petroleum Company.

Details are claimed of a process for producing synthesis gas, to be used in the Fischer-Tropsch synthesis, from a mixture of natural gas and oxygen. U.S.P. 2,605,174.

Internal-Combustion Engine Production of Synthesis Gas. E. M. Barber to The Texas Company.

A mixture of CO and H_2 is produced by the partial combustion of a hydrocarbonaceous fuel with oxygen in an internal combustion engine in the proportions approximately required for complete conversion of the fuel to CO and H_2. Details are claimed. U.S.P. 2,605,175.

Catalyst Fluidization. J. P. Hogan and R. L. Banks to Phillips Petroleum Company.

In a reaction chamber for reacting an upwardly flowing CO/H_2 gas mixture in the presence of finely divided reduced iron oxide catalyst suspended in the gas mixture, perforated, cone-shaped, upward tapering axially placed baffles of certain dimensions are arranged, whereby improved distribution and fluidization of the catalyst is ob-

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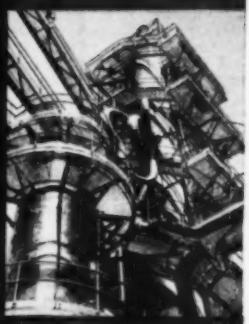

(Above) GANISTER LINING REINFORCED with KLEMP HEXTEEL (shown being welded into a cat cracker) keeps CATALYST REGENERATORS ON LINE Longer. HEXTEEL, when applied, as a reinforcement mesh is filled with a cement filler. This reduces "turn-arounds" to a minimum and helps avoid scouring and abrasive actions of the catalyst which can quickly ruin cat crackers and thermal crackers.

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tained. U.S.P. 2,606,104.

Synthesis Gas Manufacture. S. G. Stewart to Phillips Petroleum Company. C_2—C_4 paraffin hydrocarbons are partially oxidized in the presence of oxygen containing gas under special conditions of temperature and time. The resulting products are rapidly quenched by indirect heat exchange with a cracking stock which is then thermally cracked. A hydrogen and methane fraction is recovered from the cracking product and passed in part to the partial oxidation reaction. A H_2/CO mixture in an optimum ratio of 1.7:1 to 2.3:1 is recovered from the partial oxidation. U.S.P. 2,606,158.

Conversion of Hydrocarbonaceous Material into Synthesis Gas. L. Jacolev and L. P. Gaucher to The Texas Company.

Gaseous hydrocarbons are converted into H_2 and CO by partial oxidation at a temperature above 2000 F. in the presence of a suitable amount of molecular oxygen, rapid cooling of the hot effluent by indirect heat exchange with an endothermic reaction zone for converting a mixture of hydrocarbon and steam directly into H_2 and CO in the presence of a catalyst at a temperature substantially below that of the said hot effluent. The product gas from the endothermic reaction is mixed with the cooled product gas of the partial oxidation. U.S.P. 2,606,826.

Production of Industrial Gases Containing Carbon Monoxide and Hydrogen. E. S. Corner, R. V. J. McGee, and C. S. Lynch to Standard Oil Development Company.

Gaseous hydrocarbon is contacted at a temperature of at least 1600 F. with an oxygen carrier consisting of a major proportion of titania and a minor proportion of an oxide of Fe, Ni, Co, Mn, Cr, or W. A gas containing CO and H_2 is obtained. U.S.P. 2,607,668.

Production of Industrial Gases Containing Monoxide and Hydrogen. E. S. Corner and C. S. Lynch to Standard Oil Development Company.

The process of this patent is closely related to that of U. S. P. 2,607,668. The oxygen carrier here comprises a finely divided mixture of iron oxide and manganese oxide containing 10-70 percent of the latter. Further details are claimed. U.S.P. 2,607,669.

Production of Gas Mixtures Containing Carbon Monoxide and Hydrogen. W. K. Lewis, Jr., to Standard Oil Development Company.

A hydrocarbon gas is forced into a fluidized mass of a finely divided oxidizing metal oxide at a temperature of 1400-1600 F. to effect at least partial conversion of the hydrocarbon into H_2 and CO. The reaction effluent, which also contains unreacted gas and entrained metal-containing fines, is contacted with pure oxygen to completely convert the hydrocarbon gas into H_2 and CO and to sinter and agglomerate metal-containing particles. U.S.P. 2,607,670.

Regeneration of Catalyst. J. P. Hogan and A. H. Friedman to Phillips Petroleum Company.

In a Fischer-Tropsch synthesis, the flow of reactants is interrupted when the activity of the catalyst has considerably diminished; the normally gaseous phase of the reaction effluent is returned to the reaction zone to hydrogenate the CO contained in this phase, and the hydrogen-rich gaseous phase separated from the effluent thus obtained is contacted with the catalyst in the reaction zone for a period sufficient to remove at least a portion of the carbonaceous deposits therefrom. U.S.P. 2,608,568.

Production of Aromatic Hydrocarbons. S. P. Robinson to Phillips Petroleum Company.

Natural gas is heated to 1800-2400 F. for 0.1-0.5 seconds. A mixture of O and H_2 is burned to form combustion gas at a temperature of 3200-5000 F. The natural gas is further heated to 2400-3500 F. by admixing the hot combustion gas. The resulting mixture is maintained at this temperature for 0.001-0.05 seconds. An acetylene-containing product is formed which is quenched to a temperature of 1800-2300 F. by admixture of cooler hydrogen. The resulting quenched mixture is maintained at this temperature for 0.05-5.0 seconds. An aromatic-containing hydrocarbon product is formed which is rich in benzene and contains diolefins. U.S.P. 2,608,594.

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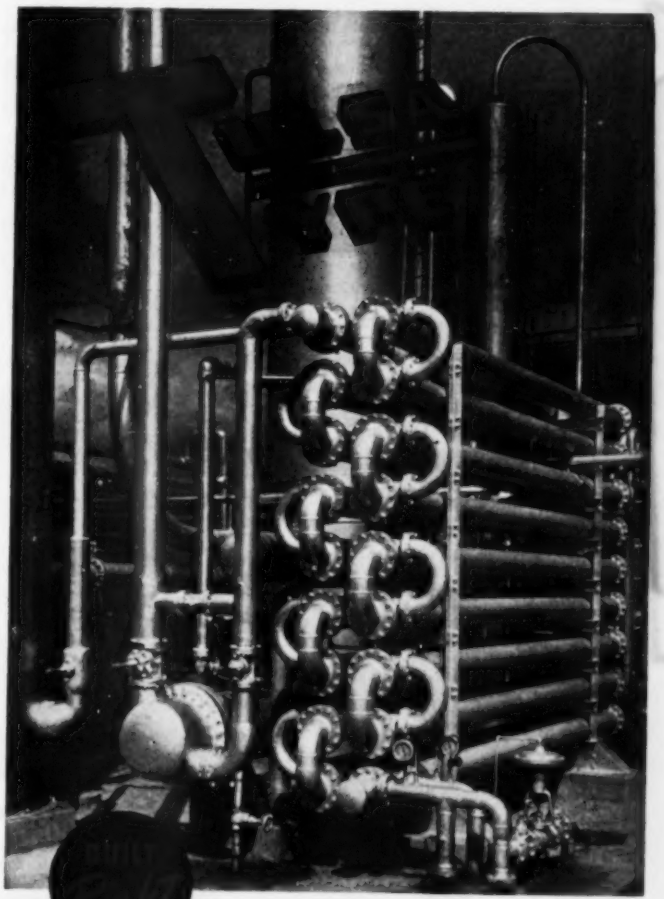

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[Patents]

Distillates. F. P. Lobban to The Texas Company.

Hydrocarbons containing phenols and mercaptans are passed successively through primary and secondary treating zones to remove the phenols and are then passed to a third zone for removal of mercaptans. In the second zone the hydrocarbons are contacted with a solution of alkali metal hydroxide of certain concentration. The phenolates thus formed are removed together with the used hydroxide solution. This solution is diluted and contacted with the hydrocarbon in the first zone. In the third zone the hydrocarbon is contacted with dethiolizing means. The method can also be employed for treating a material which does not contain mercaptans. U.S.P. 2,605,212.

Catalytic Desulfurization of Petroleum Hydrocarbons. P. Meyer to Anglo-Iranian Oil Company, Ltd.

Petroleum hydrocarbons derived from crude oil or the like are hydro-catalytically desulfurized in a continuous process by passing the overhead products of a primary distillation column for the charge material to an autofining zone, where they are contacted with sulfur resistant hydrogenation-dehydrogenation catalyst, and the products from this latter zone to a distillation zone for the separation of the hydrogen and H_2S as overhead product. U.S.P. 2,606,141.

Desulfurization of Olefinic Naphtha. J. F. Deters, A. P. Lien, and H. Shalit to Standard Oil Company (Indiana).

A high sulfur olefinic naphtha is extracted with a di-alkyl formanide to form an extract containing most of the sulfur, and a raffinate containing most of the olefins. The solvent freed extract is hydrodesulfurized and then blended with the solvent-free raffinate. An olefinic gasoline of high anti-knock value is obtained. U.S.P. 2,608,519.

Sweetening Process. E. Arundale and J. P. Thorn to Standard Oil Development Company.

Mercaptan compounds are removed from petroleum oil by its treatment with ketene. U.S.P. 2,608,520.

Process for Refining Carbonaceous Material. H. Hoog to Shell Development Company.

Hydrocarbon oil to be desulfurized is continuously passed through a bed of sulfactive hydrogenation catalyst granules together with a recycled stream of gas rich in hydrogen under specific conditions of temperature, catalyst:oil: gas ratios, and pressure. U.S.P. 2,608,521.

Hypochlorite Sweetening of Distillates. M. T. Waddell, H. W. Earhart, R. M. Love, and J. S. Tiller to Standard Oil Development Company.

In the sweetening of sour petroleum distillate by treatment with recycled alkaline hypochlorite solution, the chlorination of organic acidic bodies contained in the distillate is prevented by the addition of fresh hypochlorite solution to the recycled solution. U.S.P. 2,608,523.

Heavy Oils and Waxes

Stabilized Greases. E. L. Armstrong and R. A. Butcosk to Socony-Vacuum Oil Company, Inc.

A lubricating mineral oil fraction contains a thickening agent and a carboxylic acid type ion-exchange resin for stabilizing the resulting grease to oxidation. U.S.P. 2,605,225.

Compounded Lubricating Oil. S. C. Vaughn to Tide Water Associated Oil Company.

A hydrocarbon lubricating oil contains the additive product of an amino bicyclohexyl and alkyl acid phosphate having 8-16 C atoms per alkyl group. The additive inhibits rust formation. U.S.P. 2,605,226.

Separation of Wax Constituents and the Like from Oil. G. B. Arnold, H. V. Hess, and W. E. Skelton to The Texas Company.

Wax is separated from oil containing it by means of an organic agent which forms crystalline complexes with the waxy constituents and consists of urea, thiourea, or the like. Details of the separating process are claimed. U.S.P. 2,606,140.

Mineral Oil Compositions. H. G. Smith, T. L. Cantrell, and J. G. Peters to Gulf Oil Corporation.

A mineral oil contains a minor amount of an oil soluble phthalamidate-substituted orthophosphoric acid compound of complex constitution containing two of the amidate groups on one phos-

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SUPERIOR MANUFACTURING COMPANY

AMARILLO, TEXAS

Corrosion-resistance increased while valve maintenance reduced

THE CORROSIVE: 56% sulfuric acid sludge.

THE PLACE: Refinery of one of America's largest producers of petroleum products.

THE APPLICATION: Solution lines, temperatures to 176°F.

THE VALVE: ALOYCO 35 No. 111-A gate valve.

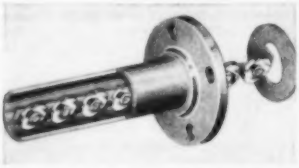
THE RESULTS: The valve has operated continuously and satisfactorily since its installation a year ago, whereas previously used valves made of commercially available materials required frequent maintenance.

THE BACKGROUND: This achievement resulted from experimentation by the *Aloyco Corrosion Clinic*—a service to chemical process engineers who encounter problems of corrosive damage to valves.

To find an alloy that would successfully resist this sulphuric concentration, an ALOYCO test rod supporting a number of different alloy specimens was inserted into a solution line. After a test period of 1104 hours, *one* specimen —ALOYCO 35, a new product of ALOYCO research—was found to have practically a total resistance to the solution. A trial valve of ALOYCO 35 was installed with the results mentioned above.

Such alloys are the result of ALOYCO's continuing study of hundreds of alloy compositions in all manner of corrosive solutions. ALOYCO maintains the only metallurgical laboratory devoted exclusively to problems relating to valves in corrosive service.

Put your problem in severe corrosives or in guarding against product contamination before the *Aloyco Corrosion Clinic.*



Orifice-type test rods exposed in customer's pipeline are studied to determine proper specification of valve material.

ALLOY STEEL PRODUCTS CO., INC.
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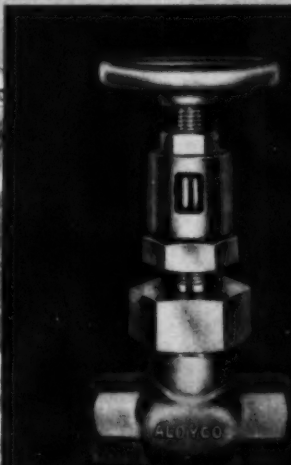
Longer Lasting

ALOYCO VALVES

1st in Corrosive Service

Lasts longer in corrosive service

ALOYCO "Teflon" seated valves have been specifically engineered to correct characteristic weaknesses commonly found in small valves used in the process industries. Like all ALOYCO valves, the trouble-free performance of these valves is the result of extensive metallurgical research and engineering and production of high alloy valves exclusively.



ALOYCO No. 62 "Teflon" Seated Valve has three outstanding features: (1) molded reversible "Teflon" seats, (2) outside stem threads, (3) union bonnet construction.

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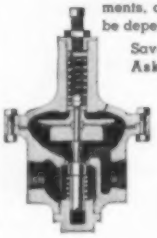
for efficient operation

Clark Pressure Reducing and Regulating Valves

are precision-made for positive pressure control on air, gas or steam lines.

Where different types of equipment, with varying pressure requirements, are operated from a common line, Clark Regulating Valves can be depended on to deliver automatically the "just right" pressure to each.

Save on fuel, maintenance and protect expensive equipment. Ask your Clark representative to specify the right Clark valves for your needs . . . or write us direct.

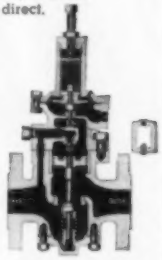


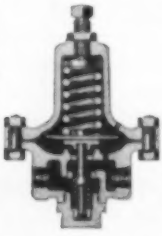
TYPE KRV

Pressure Reducing Valve. Diaphragm Operated-Single Seated Valve. Sizes ½" to 1½" for initial pressures up to 250 P.S.I. Reduced pressures to 65 P.S.I.

TYPE CRV

Pressure Reducing Valve. Integral pilot controlled, piston operated. For pressure control from "dead end" to full capacity. Sizes ½" to 6".





TYPE ORV

Pressure Reducing Valve. ¾" and ½" Single Seated, Spring Loaded, Diaphragm Actuated. For initial pressures to 250 P.S.I. Reduced pressures to 200 P.S.I.

QUICK-CLEANING STRAINERS

Remove dirt, scale and grit from steam, fluid and gas lines. Sizes ½" to 3" I.P.S. For pressures to 250 P.S.I.

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phoric acid molecule. The additive has corrosion inhibiting properties. U.S.P. 2,606,152.

Mineral Oil Composition. H. D. Hartough to Socony-Vacuum Oil Company, Inc.

A lubricating mineral oil fraction contains an additive amount of thenyl formaldimine of the formula $R^1C_4H_3SCH_2N=CH_2$ wherein R^1 is hydrogen, a lower alkyl group, or the group $-CH_2N=CH_2$. The additive deactivates metal which is in contact with the oil. U.S.P. 2,606,154.

Lubricating Composition. W. Gasser and P. R. VanEss to Shell Development Company.

A mineral lubricating oil contains one-ten percent (calculated as sulfate ash) of a mixture of oil-soluble sodium petroleum sulfonate and basic alkaline earth metal salt of an aromatic acidic compound in a certain ratio. The lubricating properties of the oil are improved by the additive. U.S.P. 2,606,872.

Fuel Oil Composition. G. W. Duncan to Standard Oil Development Company.

A distillate marine diesel fuel which is free of residual petroleum fractions containing 0.05-0.10 percent of a mixture of primary straight chain saturated aliphatic alkyl-amines having 10-16 C atoms. The additive inhibits emulsion formation of the fuel with water. U.S.P. 2,607,665.

Process of Manufacturing Hydroxy Acid Greases and Product Thereof. L. W. Sproule, W. C. Pattenden, and L. F. King to Standard Oil Development Company.

A lubricating grease consists of a mineral base lubricating oil thickened by 2-30 percent by weight of anhydrous calcium soap of a saturated mono- or dihydroxy fatty acid with 12-24 C atoms. The grease is cooked to a temperature not above 275 F. during the soap formation. U.S.P. 2,607,734.

Alkaline Earth Metal Soap Greases. L. W. Sproule, L. F. King and W. C. Pattenden to Standard Oil Development Company.

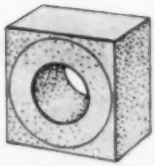
An anhydrous alkaline earth metal base grease consists of a lubricating oil and a thickener composed of a major proportion of an alkaline earth metal soap of saturated hydroxy fatty acids with 12-24 C atoms, a minor amount of a salt of the same metal having an acid radical mole weight below 160 and having the property of forming a complex with the soap to raise the melting point of the grease. U.S.P. 2,607,735.

Phosphorus Sulfide-Turpentine Reaction Products and Lubricants Containing the Same. F. M. Watkins to Sinclair Refining Company.

A mineral lubricating oil contains a minor amount of a product prepared by reacting at a temperature of 200-300 F. phosphorus sulfide with a certain type of fractionated turpentine. The additive inhibits deterioration of the oil and retards corrosion of metal surfaces. U.S.P. 2,607,736.

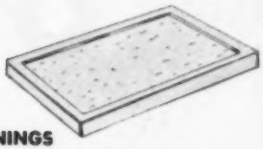
Condensation Product of a 2-Thiothia-

There's no end to the uses of economical
B&W KAOCAST



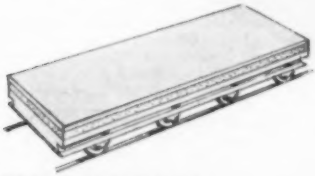
BURNER BLOCKS

Kaocast lasted 3 to 6 times as long as previous refractory. Still going strong.



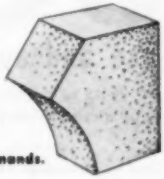
DOOR LININGS

Kaocast lasted 3 to 6 times as long as previous refractory—cut installation cost in half.



TUNNEL KILN CAR TOPS

Ordinary fireclay crumbled after few trips. Kaocast lasted 30 trips without deterioration.



SPECIAL SHAPES

Kaocast special shapes cast over week-end to meet production demands.

BOILER FURNACE REPAIRS

One power plant keeps a ton of Kaocast on hand for miscellaneous repairs because it is so versatile.

The list of plants who are discovering new, cost-saving uses of versatile B&W Kaocast keeps growing all the time. The reasons? This unique 3000 degree refractory castable can be molded in a hurry . . . cast directly in place . . . applied with a cement gun. It eliminates the need for a large inventory of special shapes. It has high resistance to spalling, low volume change, practically no reheat shrinkage. Want to know more? Ask your B&W Refractories Engineer—or write for Bulletin R-22.

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FACT

ABOUT TUBE PRICES

Alcoa Aluminum Heat Exchanger Tubes continue to have a significant price advantage over other metals. As this chart shows, Alcoa Aluminum Tubes cost ½ less than Admiralty, ⅓ less than Mild Steel, ⅕ as much as Stainless.

	PRICE PER 16 FOOT LONG TUBE			
	5/8" O.D. x .049" wall	3/4" O.D. x .049" wall	3/4" O.D. x .065" wall	1" O.D. x .065" wall
3S-H14	$1.12	$1.23	$1.55	$1.99
Alclad 3S-H14	1.42	1.64	1.95	2.55
Seamless Mild Steel	2.44	2.56	2.90	3.18
Admiralty Brass	2.96	3.39	4.46	5.85
Cupro Nickel (30%)	4.26	5.11	6.50	8.88
Stainless Steel (304)	9.09	10.02	11.41	13.72

NOTE: Prices for 3S-H14 and Alclad 3S-H14 based on lots of 2000—4999 lbs. For Admiralty and Cupro Nickel, based on 5000 to 9999 lbs. Prices for Mild Steel and Stainless based on lots of 10,000 ft. with assortment of sizes. T.O.D. x .065" wall which is based on 5000 ft.

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- Lube oil coolers
- Natural gas compressor after-coolers
- Recompressor after-coolers
- Hydrogen sulfide gas coolers
- Furfural condensers and heat exchangers
- Propane chilling
- Wax sweaters
- Lean oil—rich oil exchangers
- Amine solution coolers
- Glycol-amine heat exchangers and reboilers

CHEMICAL

- Butanol
- Ethanol
- Ethylene Glycol
- Glycerin
- Hydroabietyl
- Isopropanol
- Methanol
- Phenol
- Propylene Glycol
- Acetaldehyde
- Formaldehyde
- Furfural
- Heptaldehyde
- Acetic acid
- Stearic, Palmitic, Maleic, Oleic acids
- Butyric acid
- Naphtha
- Ricinoleic acid
- Acetanilide
- Ammonia
- Hydrogen Cyanide
- Nitric acid (concentrated)
- Pyridine
- Hydrogen Sulfide
- Benzene
- Dichlorobenzene
- Gelatin
- Hydrogen Peroxide
- Turpentine
- Xylene

Use Alcoa Alclad 3S-H14 Heat Exchanger Tubes with fresh, brackish and salt-cooling waters

zole, Formaldehyde, and Alkyl Phenol to Inhibit Sulfur Corrosive Lubricants. R. L. Woodruff, W. T. Stewart, and W. Lowe to California Research Corporation.

A major proportion of sulfur-containing lubricating oil contains a minor amount of the reaction product of equimolecular proportions of a 2-mercaptothiazole, formaldehyde, and an aliphatic alkyl phenol having 12-18 C atoms in the alkyl group, heated together at a temperature above 105 C. The additive inhibits corrosion of silver by the oil. U.S.P. 2,607,737.

Dewaxing Process Using Filter Aid. J. L. Tiedje to Standard Oil Development Company.

Diluted waxy oil is mixed with a small quantity of pitch from a waxy crude. The mixture is chilled to solidify the wax, which is separated from the oil. The wax is vacuum distilled. The wax bottoms thus obtained are added to a second batch of diluted waxy oil. The separation of the waxy constituents of the oil is greatly improved by this addition. U.S.P. 2,608,517.

Reduction of Corrosion in Solvent Dewaxing Plants. R. L. Green to Standard Oil Development Company.

In the dewaxing of hydrocarbons by solvents in a special manner corrosion in the solvent stripping zone by the CO_2 dissolved in the water and solvent used is prevented by the passage of flue gas. U.S.P. 2,608,518.

Process for Producing Superior Motor Fuel. P. H. Johnson and G. J. Forseth to Phillips Petroleum Company.

A mixture of naphthenic naphtha and gas oil is contacted with a bauxite catalyst at a temperature of 900-1050 F. and a pressure of 0-300 psi. The gasoline fraction of the effluent obtained consists of a low-boiling half comprising primarily olefins and a higher boiling half comprising primarily aromatics and naphthenes, and represents a superior road rating motor fuel. U.S.P. 2,608,524.

Petrochemicals

Photochemical Preparation of the Delta Isomer of Benzene Hexachloride. F. N. Alquist and K. C. Kauer to The Dow Chemical Company.

Benzene dissolved in chlorinated methanes or liquid chlorinated ethanes in a certain ratio is photo-chlorinated at a temperature of 0 to —30 C. in the presence of a benzothiazole or mercaptobenzothiazole catalyst. An isomeric mixture of benzene hexachlorides is recovered containing over 17 percent of the delta isomer. U.S.P. 2,606,808.

Gaseous Phase Photohalogenation of Hydrocarbons. J. A. Pianfetti and R. W. Timmerman to Food Machinery & Chemical Corporation.

Hydrocarbons and a halogen are passed into a zone where reaction is caused by photochemical catalysis. The effluent gases are passed through a zone containing a solid catalyst, whereby the unchanged portion of the halogen is combined with unhalogenated

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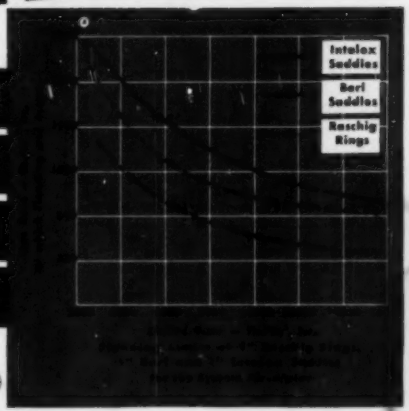

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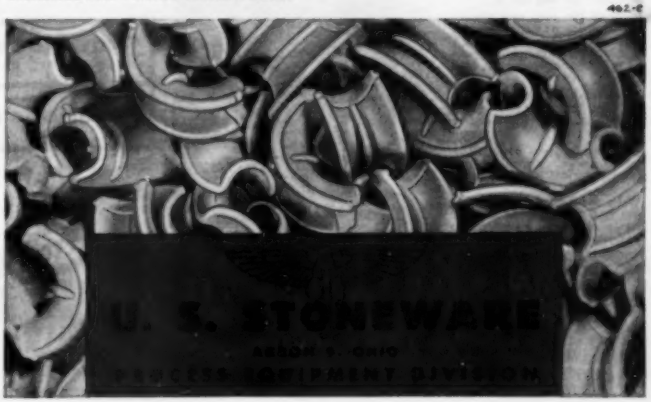


[Patents]

hydrocarbons or its partially halogenated derivatives. U.S.P. 2,606,867.

Production of Unsaturated Carbonylic Compounds. R. M. Cole, C. L. Dunn and G. J. Pierotti to Shell Development Company.

In the production of alpha-methylene aldehydes and ketones with three C atoms, normally gaseous hydrocarbons comprising an olefin with three-four C atoms are subjected to olefin oxidizing conditions. The resulting reaction mixture is contacted with a stream of liquefied normally gaseous hydrocarbons of the same type to absorb the unsaturated carbonyl compounds formed. Upon stripping the hydrocarbons from the liquid phase obtained, they are passed into the reaction zone. U.S.P. 2,606,932-3.

Production of Hexachlorocyclohexane. J. A. Pianfetti, M. Y. Seaton, and D. Williams to Food Machinery & Chemical Corporation.

Chlorine is mixed with benzene in an excess adequate to maintain the resulting hexachlorocyclohexane in solution. The mixture is agitated while irradiated by actinic light. Exothermic heat is withdrawn from the walls of the reaction zone. On distilling off the excess benzene, the hexachlorocyclohexane is obtained in molten form and is solidified by cooling after removal from the distillation zone. U.S.P. 2,607,723.

Process for Manufacturing Bromoxylenes. H. F. Johnson, Jr. and H. W. Scheeline to Standard Oil Development Company.

A gaseous stream of bromine, air, and xylene is contacted with a catalyst comprising $CuBr_2$, ThO_2 and CeO_2 at a temperature of 300-600 F., the ratio of xylene:bromine being 10-25 times the theoretical requirement and that of air: bromine 1.8-2.5 times the theoretical requirement based on the reaction of two moles of xylene with one mole of bromine and ½ mole of oxygen. The bromination product is washed with caustic and is fractionated to segregate a monobromo xylene fraction and an unreacted xylene fraction, which is recycled. U.S.P. 2,608,590.

Substitution Chlorination of Aromatic Compounds with Liquid Chlorine. F. E. Lawlor to Niagara Alkali Company.

Monocyclic aromatic hydrocarbons having at least one chlorine-replaceable hydrogen attached to a nuclear C atom are dissolved in an amount of liquid chlorine in excess of that to be reacted with the hydrocarbon. The solution is maintained in the presence of a chloride chlorinating catalyst at a pressure to keep chlorine in the liquid state at the temperature employed, said temperature being one not over 80 C. Nuclear chlorine substitution products of the aromatic hydrocarbons are obtained. U.S.P. 2,608,591.

Fluorination Process. R. D. Fowler and H. C. Anderson to the U.S. Atomic Energy Commission.

A vaporized hydrocarbon, e.g. a lubricating mineral oil, is reacted with solid CeF_4 at a temperature of 100-450 C. and above the boiling point of the hydrocarbon. All hydrogen atoms of the hydrocarbon are replaced with fluorine while the carbon structure of the feed hydrocarbon is retained. U.S.P. 2,608,593.

Apparatus for Halogenation. H. J. Noebels to Heyden Chemical Corporation.

An apparatus is claimed for the production of halo-alkyl benzenes from the corresponding alkyl benzenes, such as toluene and xylene. The apparatus has an all-glass bubble cap column accessible to actinic rays. Details of construction are also claimed. U.S.P. 2,608,660.

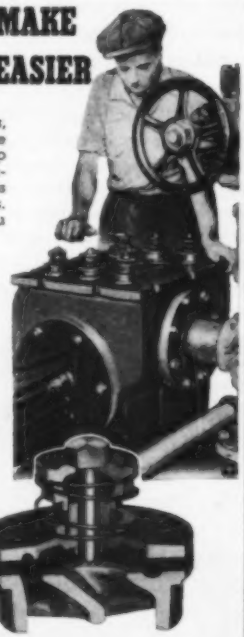
Selective Oxidation with Suspended Catalyst. W. F. Rollman to Standard Oil Development.

C_3 to C_4 olefins and aromatic compounds are partially oxidized by flowing the reactant in vapor phase to contact with an oxidation catalyst suspended in an oxygen-containing gas under special conditions of temperature and period of contact. U.S.P. 2,604,479.

Iron Removal from Aldehyde Synthesis Process. C. H. Hale to Standard Oil Development.

In the carbonylation of olefins by treatment with CO and H_2 in the presence of a cobalt carbonylation catalyst, the reaction effluent is treated with an aqueous solution of alkali metal or tetramethyl ammonium hydroxide, or the like. Metal hydroxides are precipitated and dispersed metals occluded from solution. U.S.P. 2,604,491.

HOW YOU CAN MAKE PUMP REPAIRS EASIER



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You get longer service from seats and discs because of rotating disc that changes to a new seating-surface every time it opens. Valves can't hammer up and down.

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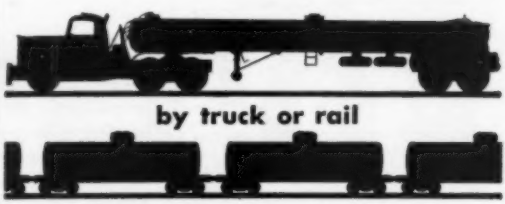


by truck or rail

WHERE AND WHEN **YOU** WANT IT

* caustic soda (FLAKE, SOLID, LIQUID)	* chlorine
* muriatic acid	* oil well and industrial salt

ANYWHERE IN THE ROCKY MOUNTAIN, MID-CONTINENT AND SOUTHWEST AREAS

Frontier Chemical Company — ELECTRO-CHEMICAL MANUFACTURERS

GENERAL OFFICES 321 WEST DOUGLAS WICHITA, KANSAS PHONE 7-3215

GEARED TO SERVE THE OIL INDUSTRY

Wichita, Kansas • Denver City, Texas • Midland, Texas • Denver, Colorado

PERCO*

CYCLOVERSION* AT CENTRALIA • ILLINOIS

Advance Refining Company now has this 650 barrels per day Cycloversion unit on stream for efficient catalytic cracking of gas oil.

Engineering and construction by Grebe & Doremus Process Company, Houston, Texas. Much of this new facility was shop fabricated on skids for rapid installation.

How about Cycloversion for you? It's versatile—run it for catalytic desulfurization, catalytic cracking or catalytic reforming—depending on *your* requirements.

PERCO DIVISION PHILLIPS PETROLEUM COMPANY BARTLESVILLE, OKLA.

*A SERVICE MARK

The Hallmark of Circulation Value

AUDITED PAID CIRCULATION ABC

HERE'S WHAT THE "ABC" INSIGNE MEANS TO YOU

Every copy of *Petroleum Refiner* has a *plus* for you, because this magazine is a member of the Audit Bureau of Circulations. It is a paid subscription paper that must *earn* its readership by sustained editorial quality.

For three decades, *Petroleum Refiner* has been known for the technical accuracy and volume of its editorial content. It regularly carries in each issue more refining, natural gasoline and petrochemical reading material than any other oil magazine.

A GUARANTEE OF PUBLISHING INTEGRITY

The ABC insigne is a guarantee of publishing integrity. It means that the circulation is regularly checked by impartial ABC auditors. Certified statements give analyses on the circulation, where it goes, how it is sold.

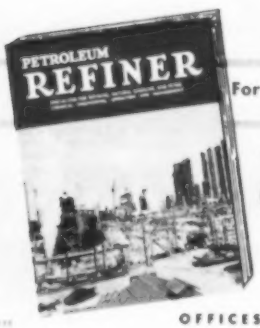
Yes, the ABC insigne on your business magazine means you get full value for your subscription dollars. Every issue you receive must meet the strict requirements of the world's highest publishing standards.

Remember, when comparing *Petroleum Refiner* with any other oil magazine you might receive, that . . .

. . . the measure of a publication's quality is determined not by the number of readers the publication wants—but by the number of *readers who want the publication.*

. . . today more refining men pay to read *Petroleum Refiner* than ever before has been true of any magazine in the history of this industry.

As a member of the Audit Bureau of Circulations, *Petroleum Refiner*'s editors know they must deliver the editorial values that earn paid subscriptions from you and 10,184 other men in this great industry.



For Refining, Natural Gasoline and Petrochemical Operations

A SPECIALIZED PETROLEUM PUBLICATION OF

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OFFICES AT: NEW YORK, CHICAGO, CLEVELAND, TULSA, LOS ANGELES

What's New in Books

Petroleum Conservation

Petroleum Tankage and Transmission, H. L. O'Brien, Graver Tank & Manufacturing Company, Inc., East Chicago, Ind., $5.

A composite of all current information relating to the title, this 176-page book represents Graver's experience in the world of petroleum and the experiences of the many oil companies Graver has served. It includes previously published material, other data known and in use but never before published and a great deal of new information collected by Graver petroleum authorities over a period of years.

The presented material is organized into four chapters which discuss: 1. The effects of temperature, vapor pressure, and vapor volume space on evaporation, and standard cone tanks. 2. Various pieces of conservation equipment, including the expansion roof tank, vapor-mizer, floating roof tank and several pressure vessels. 3. The specific advantages of certain types of equipment over others. 4. The many variables affecting viscosity. The different pipe lines which have been found suitable for transmitting various products.

The essential thesis of the book is the problem of conservation, which is offered with the support of numerous full-page graphs, charts, numerical examples and photographs.

Petroleum Industry Reviewed

Reviews of Petroleum Technology, Vol. 12, The Institute of Petroleum, 26 Portland Place, London, W. 1., 513 pages, two pounds, ten shillings (about $6.98).

This volume, covering the year 1950, deals with practically all phases of the petroleum industry. Over 3300 references to articles which appeared in the literature of the period under review are included, along with a few reviews which cover the period 1949-50, these being on general geology and development, engine testing (both fuels and lubricants), furnace fuel oil, lubricants, and engines and automotive equipment.

New API Booklet Explains Organizational Set-Up

A new booklet which explains its operations and organizational set-up has been published by the American Petroleum Institute and is now available to the membership, and other interested associations, firms and individuals. The booklet gives a brief summary of facts about the American Petroleum Institute, its history, aims and objectives, as well as its services to the industry. The first section of the booklet covers the API—what it is and what it does; how it is organized; who makes its policy; who does the work; who administers the work; scope of its activities; what the members do; and why become an Institute member?

The second and third sections contain individual chapters on the various divisions and service departments, explaining the organization and functions of each. A centerspread shows how the Institute is organized.

New Applications Of Hydrides

An Introduction to the Chemistry of the Hydrides, Dallas T. Hurd, John Wiley & Sons, 440 Fourth Avenue, New York, 231 pages, $5.50.

In this comprehensive description of the theory, properties and reactions of the hydrides, the author discusses their preparation as well as their industrial and research applications. Toxicology and the techniques of handling hydrides and hydride compounds are also covered.

26th Annual Priestley Lectures On Radioactive Atoms Published

A transcription of the 26th Annual Priestley Lectures entitled, "Radioactive Atoms and Isotopic Tracers" has been published by Phi Lambda Upsilon and Pennsylvania State College. The lectures were delivered by Dr. Joseph W. Kennedy, and cover nuclear transformations, uranium, fission and transuranium elements, isotopic tracers and electron transfer reactions, quantitative kinetic studies with tracers and self-diffusion of aqueous ions. The book is available from Pennsylvania State College, Departments of Chemistry and Chemical Engineering, State College, Pa., for $2.

Infrared Spectra Data

A comprehensive punch-card catalog of all available data on the infrared spectra of organic compounds is being set up by the National Bureau of Standards under the sponsorship of the National Research Council. The task of compilation is now well under way, and the first of the punch cards containing spectra, bibliographic information and other useful data on 45 compounds are being made available to industrial and research laboratories.

Designed to supply workers in the fields with results obtained by others, the infrared card catalog provides a series of spectral curves with which the spectra of the unknown compounds can be compared. It makes data needed for theoretical computations available without the use of expensive sorting equipment. By means of the cards, the reported spectra of many compounds can be quickly found, the more important chemical linkages associated with a given spectral line can be determined, the work of any given author can be quickly assembled and the properties of a compound which will aid in its identification can be located without loss of time.

Estimated cost to subscribers, exclusive of sorting and filing equipment, will be between $200 and $250 during the first year of operation.

Friction, Wear Study

Le Frottement Et L'Usure (Friction and Wear), National Advisory Committee for Aeronautics, 1724 F Street, Washington 25, D. C., Code No.: PB 106628.

This report covers a general survey of the field of friction and wear; and includes discussions of hydrodynamic lubrication, boundary lubrication, seizure and dry friction.

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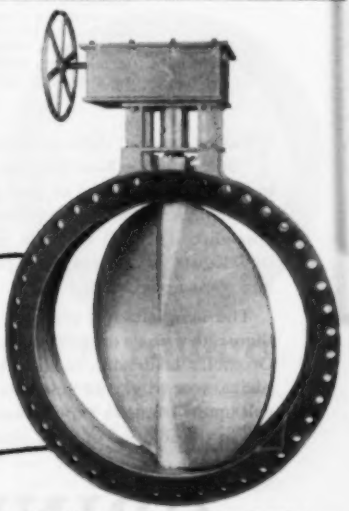
Free Flow

Quick Control

Tight Shut-Off



W. S. ROCKWELL BUTTERFLY VALVES

★ Minimum pressure drop—when fully open, valve practically as free as pipe itself.

★ Uniform, quick control manually or automatically.

★ Positive shutoff—commercial, drip tight or air tight.

★ Pressures to 600 p.s.i. Temperatures to 2000° F.

★ Made of any metal or rubber lined.

★ Sizes—1" to 72" and larger.

W. S. Rockwell 54" heavy duty butterfly valve; for 50 p.s.i.; with geared handwheel operator. May be equipped for electric, pneumatic or air operator control.

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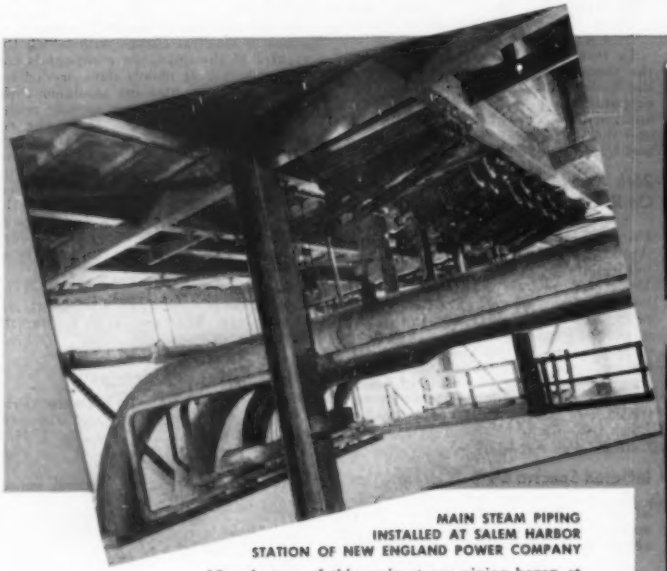
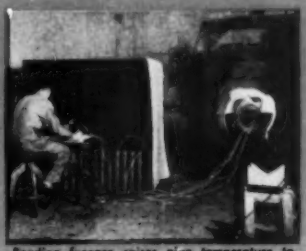
What it takes to make steam behave *at 1450 psi and 1000° F!*



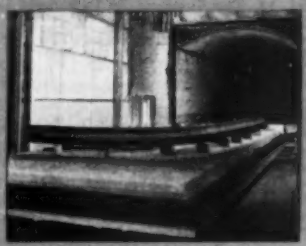
MAIN STEAM PIPING INSTALLED AT SALEM HARBOR STATION OF NEW ENGLAND POWER COMPANY

Manufacture of this main steam piping began at Pennsylvania Forge Corporation as 20-ton alloy-steel ingots (2½% chrome, 1% moly steel). Four days' forging changed the ingots into solid bars 30 ft. long, with outside diameter of 15½ in. Boring, turning, sizing and finishing followed.

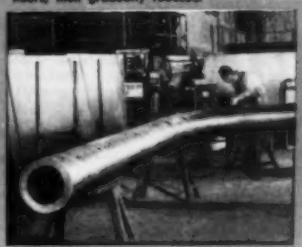


Bending furnace raises pipe temperature to 2000°F in 3 hours, 40 minutes. Thermocouples and pyrometer measure pipe temperature.

Skilled team completes bend in six minutes. Inside surface temperature dropped about 100°F.



Bend being loaded into furnace for stress relieving. Heat maintained at 1425°F for 4½ hours, then gradually reduced.



Ultrasonic inspection of wall after cleaning of pipe shows maximum thinning in bend of 1/16 inch.

FABRICATION of the main steam line for the Salem Harbor Station of the New England Power Company, vital link in more than 52 miles of piping fabricated by Grinnell, is an example of the *many* skills required of Grinnell piping specialists. Grinnell chemists, metallurgists, physicists and radiologists . . . *all* played a part in the bending, welding and testing operations.

The integration of complex, highly technical skills like these into a *single* organization of trained specialists explains Grinnell's leadership in the field of prefabrication. It explains, too, why your interests are best served when you call upon Grinnell's expert personnel and specialized facilities in the solution of your piping problems.

GRINNELL

WHENEVER PIPING IS INVOLVED

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

[What Suppliers Are Doing]

Baroid Sales Division Names Three to Houston Headquarters

Baroid Sales Division of the National Lead Company, with national headquarters in Houston, recently added three new men to its Houston office. H. H. Heath has been named comptroller of the division and his new assistant is Gordon Robertson. Ben A. Weil was added to the advertising department.

Heath

Robertson

Weil

Heath, a Baroid employe since 1943, and a graduate of Loyola University, is currently associate director of the National Association of Cost Accountants.

Robertson has been with the Baroid organization since May, 1949, and is a graduate of the University of Minnesota. Weil previously headed his own advertising agency in Corpus Christi, Texas, and is a 1948 graduate of the University of Texas.

$1 Million Plant Expansion Planned By Wagner Electric

Wagner Electric Corporation, St. Louis, Mo., recently announced plans to expand its transformer plant. The company has purchased from the Fulton Iron Works Company a piece of property adjoining the Wagner main plant. This property, consisting of about three acres of land and four buildings having a combined floor area of more than 100,000 square feet, will be used to house Wagner's expansions.

The newly-acquired buildings will be completely renovated and modernized, and the manufacture of large distribution, small power and all unit substation transformers will be concentrated in this section.

Completion of the planned expansion and conversion program will require approximately one year, and the cost is estimated at $1 million.

B&W Division Enlarges Cleveland Sales Office

The Cleveland district sales office of the Tubular Products Division, The Babcock & Wilcox Company, has moved into larger facilities in downtown Cleveland. Ray E. Fleeson is in charge of the office.

Kerotest Bought By Tube Turns; New Management To Run Plant

Tube Turns, Inc., of Louisville, Ky., has completed arrangements for the acquisition of all of the common stock of Kerotest Manufacturing Company, Pittsburgh. The new management has already taken over operation of the plant.

Kerotest will continue to be operated under its own name and present officers and personnel have been retained. New officers: all of Tube Turns, are George O. Boomer, chairman of the board and John G. Seiler and Robert J. Landolt, vice presidents. Walter G. Swaney, incumbent vice president and secretary, and J. D. Isaacks, vice president of Kerotest, remain in the same capacities. The presidency will be filled at a later date.

Carlon Products Appoints Kansas Firm As Sales Division

Carlon Products Corporation has designated Green Contracting & Engineering Company located at 103 South Vine, Wichita, Kans., as oil country sales division of the organization. As a Carlon distributor for the past four years, Green has pioneered in the application of plastic pipe in the petroleum industry, and will make this engineering and applicational knowledge available to supply houses and distributors servicing the oil country installations.

Eastern Sales Staff Addition Made by the Duraloy Company

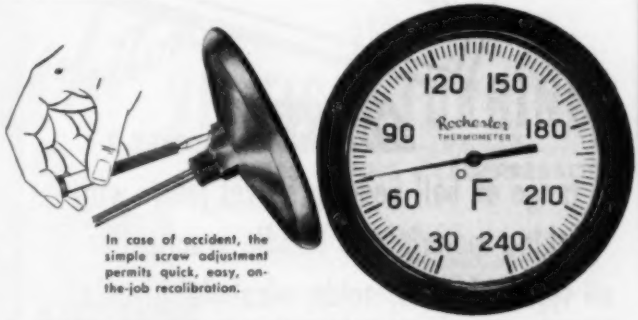
The Duraloy Company, Scottdale, Pa., has announced the appointment of Dan W. Talbott to its eastern sales staff in New York. Other members of this staff are Dave Marsden, former district sales manager, and W. F. Furman, former vice president of the company.

Talbott

Talbott, a graduate of Carnegie Tech and until recently vice president of Cooper Alloy Foundry Company, has a background of almost 25 years of experience in the high alloy casting business, both production and sales.

Minneapolis-Honeywell Sets UP Valve Research Center

A research center has been established in Philadelphia by the Valve Division of Minneapolis-Honeywell Regulator Company to support an extensive development program in industrial valves. The test and research equipment, housed in a two-story brick building, will evaluate present valve design and performance as well as implement research into new valve types to parallel advances being made in modern process control. An elaborate hydraulic laboratory is built into the research center to measure valve capacities and the static and dynamic in-



In case of accident, the simple screw adjustment permits quick, easy, on-the-job recalibration.

DON'T DROP IT! BUT IF YOU DO...

ROCHESTER DIAL THERMOMETERS are built to take severe blows without damage to their sensitive movements. But when hit hard enough to knock them out of adjustment, all you need is a screwdriver to put them right back on the job—as accurate as ever. This unique Rochester recalibration feature eliminates the danger of costly production errors due to inaccurate readings.

WELDED STAINLESS STEEL construction makes Rochester thermometers more durable, sensitive, pressure tight and resistant to corrosion than any before offered. Backed by 35 years of instrument making experience.

ORDER TODAY from your Rochester Representative, or write for further details. Rochester Manufacturing Co., Inc., 38 Rockwood Street, Rochester 10, N. Y.

Rochester Manufacturing Company, Inc.
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DIAL THERMOMETERS · GAUGES · AMMETERS

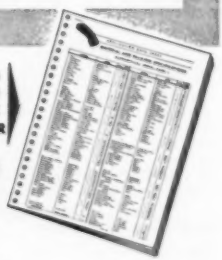
An Invitation to the Chemical Industry from Chiksan Engineering

CHIKSAN makes a range of ball bearing swivel joints with packing materials to handle practically all types of salts, acids, alcohols, glycols, aldehydes, alkaline solutions, animal oils, aromatics, chlorine derivatives, volatile gases and soaps.

Whether it's propane, butyl alcohol, vegetable oils or sulphuric acid, CHIKSAN loading racks with ball bearing swivel joints can be depended upon to handle these hard to handle chemical products with ease, economy and complete safety.

Chiksan has material and packing specification sheets listing 317 chemical products with recommendations for types of joints, metal and packing material to be used.

Write for Chiksan Application Data Sheet and Catalog 51-C Dept. No. 10-PR



The Flow of Enterprise Relies on

CHIKSAN

Ball-Bearing Swivel Joints

Representatives in Principal Cities

CHIKSAN COMPANY • **BREA, CALIFORNIA** • **Chicago 28, Illinois** • **Newark 2, New Jersey**

• Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan Export Company (Subsidiary), Brea, California • Newark 2, N. J. •

ternal forces of valves. More than 2000 gallons of water a minute can be pumped through the test stand under pressure up to 100 pounds per square inch. High temperature testing equipment will measure the strength of valve components at temperatures up to 700 °F. A modern model shop supports the research program.

Filtrol Corporation Appoints R. S. Milton Purchasing Agent

R. S. Milton has been appointed purchasing agent of Filtrol Corporation and will be responsible for purchasing practices and procedures for all Filtrol plants. He has been active in the company since 1937 when he was in charge of purchasing for California operations and sales department coordination. A graduate of Harvard in 1915, Milton has also been associated with the American Potash and Chemical Corporation, International Filter Company, and DeLaval Steam Turbine Company in sales and purchasing work.

Milton

Larimer Named General Sales Manager for Ansul Divisions

Ansul Chemical Company, Marinette, Wis., has appointed Paul R. Larimer general sales manager in charge of all four sales divisions—fire extinguisher, refrigeration, industrial chemicals and export. This is a new post created by the company to help supervise and coordinate the company's sales expansion.

Larimer formerly supervised the company's government relations program and served as assistant sales manager of the Fire Extinguisher division. At one time, he was co-owner of Thunderbird Sales Corporation, Phoenix, Ariz., a distributor of Ansul fire extinguisher equipment.

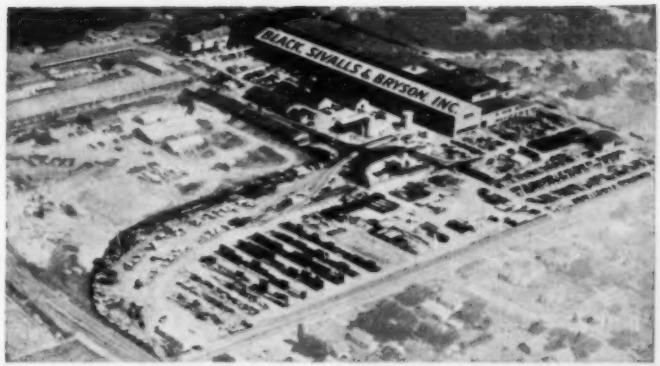
Larimer

Western Fiberglas Territory Extended By Gustin-Bacon

Gustin-Bacon Manufacturing Company, producer of Ultralite glass fiber insulation, has extended the distributing territory of Western Fiberglas Supply Company to include the entire Pacific Coast and Alaska. Western Fiberglas Supply previously had been distributor for Ultralite in the Los Angeles and San Francisco areas.

Leeds & Northrup Sales Office Has New Philadelphia Address

The Philadelphia district sales office of Leeds & Northrup Company has moved into new and larger quarters at 444 North 16th Street. The company's advertising department and training school will occupy the remaining space at the new five-story building address.



Completes Sixty Years of Service to Industry

Shown above is the enlarged Oklahoma City, Okla. plant of Black, Sivalls & Bryson, Inc., part of the company's recently completed $2 million expansion program. Coming as the company celebrated its sixtieth year of continuous operation, the program consisted of major expansion of the company's Oklahoma City and Kansas City, Mo. plants, and expansion and relocation of its Odessa, Texas facilities. The Oklahoma City plant expansion, providing for 57,000 square feet of added manufacturing area, included a new 600 x 80 foot heavy pressure vessel welding bay, served by a heavy plate oven and new stress-relieving oven, a new steel plate bending roll which will roll up to three inches of cold plate, and two heavy duty cranes. About 78,000 square feet of manufacturing and storage space have been added at the Kansas City plant, including a new machine shop bay, enlarged heat-treating facilities and new shop offices. During the sixty years of its operations, BS&B has grown as the oil industry expanded its production activities. Today the company manufactures automatic controls and safety devices in addition to oil and gas field processing equipment.

Pennsalt Names Plant Manager

Vance N. Wilson, supervisor of personnel administration in Pennsylvania Salt Manufacturing Company's Philadelphia office, has been appointed superintendent of the Bryan, Texas, plant to relieve Howard L. Teer of production

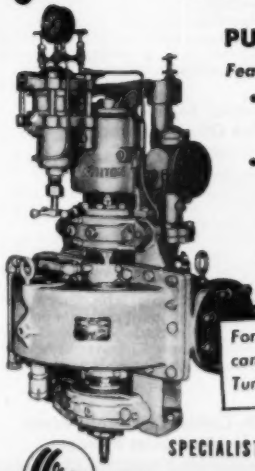
Whiton

SOLID STEEL ROTOR

VERTICAL TURBINES

Economical—Dependable . . . for

PUMPS • FANS • COMPRESSORS



Featuring:—

- SOLID STEEL ROTOR . . . gives high efficiency for low-speed, direct drive.
- LABYRINTH SHAFT SEAL . . . positively prevents leakage. Eliminates wear and seizing.

Available in various types and frame sizes up to 600 Horsepower.

For full information on how Whiton Turbines can fill your requirements, write directly to our Turbine Division.

SPECIALISTS IN HORIZONTAL AND VERTICAL TURBINES.

WHITON MACHINE CO.

NEW LONDON 14, CONN., U.S.A.

It pays
to use
MACBETH
brand
Flat Gauge Glasses for
High-Pressure Boilers

The high-heat resistance of MACBETH Brand Gauge Glasses means safer operation and longer life for high pressure boiler service. Designed now for pressures up to 1500 p.s.i. for steam boiler use and up to 5000 p.s.i. at normal temperatures. Uniform dimensions assure tight, accurate fittings on all standard gauges. Made of hard, chemically resistant glass, they stay clear under the most difficult operating conditions. They are easy to read, even from a distance.

Two types of MACBETH Brand Gauge Glasses available—Type A (Plain) used in pairs with water column between—Type B (Reflex) with full length prisms used singly with prisms on water side.

Higher safe operating pressures can be maintained because the low coefficient of expansion of MACBETH Brand Gauge Glasses permits heavier glass construction for additional mechanical strength.

Order MACBETH Brand Flat Gauge Glasses from your Mill Supply Distributor. He also stocks PYREX and CORNING Brand Tubular Gauge Glasses, PYREX Brand Sight Glasses, Oil Cup and Lubricator Glasses.

MACBETH
CORNING
GLASS WORKS
Corning, New York

VISIT THE CORNING GLASS CENTER

duties. Teer, district manager for agricultural chemicals, will devote all his time to sales activities.

J. E. Gambrill Named to Head Moore Products New York Office

Gambrill

Announcement has been made of the recent appointment of J. E. Gambrill as manager of the Moore Products Company's new branch office in New York.

Gambrill has been manager of the company's Detroit branch office since 1945. Prior to joining the Moore organization in 1943, he was in the operating department of the Atlantic Refining Company.

He received a B.S. in chemical engineering and a Ch.E. degree at the University of Pennsylvania in 1929 and in 1941 respectively.

Adams Named Assistant Chief Of Tagliabue's Engineering

Adams

Earl F. Adams has been named assistant chief engineer of Weston Electrical Instrument Corporation's Tagliabue Division, Newark, N. J.

Adams, formerly Tagliabue's pyrometer group chief, joined Weston 29 years ago as a development engineer. In 1938, he became a technical correspondent and four years later returned to engineering development work.

Among his inventions are an averaging thermometer for oil storage tanks in addition to a remote selector mechanism for the averaging thermometer and a temperature recorder for turbo-jet engines.

Consolidated Engineering Opens New York Office for Subsidiary

Consolidated Engineering Corporation has opened new and larger offices for its subsidiary company, CEC Instruments, Inc., at 285 Madison Avenue, New York City.

The offices will handle sales and services for Consolidated Engineering's line of analytical instruments for science and industry, including the company's newly announced electronic computer and automatic data handling equipment.

Walter J. Beagan, New York and northeastern United States manager, will be in charge of the New York offices.

Carbide, Carbon Chemicals Names Brown Assistant Sales Manager

Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation, has announced the appointment of R. F. Brown as an assistant sales manager in the company's Industrial Chemicals division. A former Midwestern division

W-K-M
VALVES
FOR THE
TOUGH JOBS

W-K-M PROPANE VALVES

• The success of these efficient valves in propane service is proof of the superiority of the W-K-M basic design. To this sound design, W-K-M engineers added a teflon safety seal to produce the positive-shutoff W-K-M Propane Valve. Even if fire strikes, this valve will seal 100%, for if the teflon seal should burn out, the conventional steel-to-steel seal remains to prevent leakage.

W-K-M Valves for process service utilize the proved W-K-M expanding gate design, which provides a smooth bore right through the valve. Only in W-K-M Valves are the gates activated by the Leverlock Cam construction which guarantees years of positive operation at any temperature or pressure within the range of the valve.

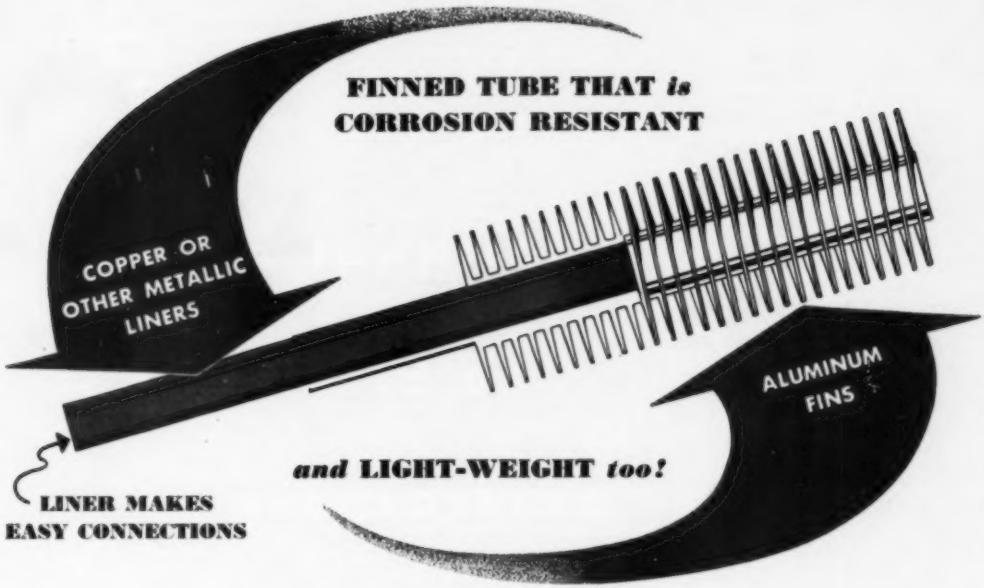
W-K-M Process Valves are in service in fluid catalytic cracking units, propane de-asphalting units, vapor recovery units, hydroforming units and refinery fuel systems.

Write for Bulletin #698 for complete data concerning W-K-M Process Valves.

W-K-M COMPANY
P. O. BOX 2117 HOUSTON 1, TEXAS
727 W. Seventh Street, Los Angeles, Calif.
EXPORT OFFICE:
30 Rockefeller Plaza, New York, N. Y.

W-K-M Valves

AVAILABLE NOW...


FINNED TUBE THAT *is* CORROSION RESISTANT
COPPER OR OTHER METALLIC LINERS
ALUMINUM FINS
and LIGHT-WEIGHT *too!*
LINER MAKES EASY CONNECTIONS

Wolverine Trufin* in *bi-metal* was developed to meet customer demand for a more effective heat transfer application than could previously be obtained with applied fin tubes. After years of research and experimentation, Wolverine product engineers came up with an ideal development: *An economical finned tube*—incorporating integral aluminum finned tube and liners of copper or copper base alloys.** The integral finned tube and liner are joined mechanically. This rugged construction is capable of withstanding extreme temperatures and vibration.

Actual applications have revealed that the heat transfer efficiency of Trufin is sometimes *nine times* that of plain tube! In many instances the use of Wolverine Trufin has resulted in low-cost installation and maintenance with maximum heat transfer efficiency.

Trufin in *bi-metal* is tough; it's durable and is as easy to fabricate as plain tube! Liners of Trufin *bi-metal* are extended to permit easy installation.

Wolverine Trufin in *bi-metal* is available in many sizes and fin spacings.

Send for your copy of Wolverine's illustrated Trufin brochure. **WOLVERINE TUBE DIVISION,** Calumet and Hecla Consolidated Copper Company, Inc., *Manufacturers of tubing exclusively.* **1431 Central Avenue, Detroit 9, Michigan.**

Wolverine also manufactures plain condenser tube in copper and copper base alloys.

*REG. U. S. PAT. OFF.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

***Liners of steel and its alloys are also available.*

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
Sales Offices in Principal Cities

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manager with headquarters in Chicago, Brown will take over his new duties in New York, while R. M. Joslin, Jr., will take over his position in Chicago. Joslin is a former district manager of the Philadelphia area.

Charles Gribble Named Sales Head For Houston Metal Goods

Metal Goods Corporation of Houston, a division of Metal Goods Corporation, St. Louis, recently announced the appointment of Charles G. Gribble, Jr., as manager of sales, Houston division. He joined Metal Goods in 1946 as a sales representative. He has served 15 years in the metal-working and metal-processing industries, including three years active duty as the Foundry Superintendent of the U. S. Naval Repair Base in San Diego. Gribble is chairman of the Houston Chapter of the National Association of Corrosion Engineers, and is a past member of the Board of Directors of the Texas Chapter of the American Society for Metals.

Gribble

Norge Heat Division Moved

Borg-Warner Corporation has announced a plan to move the offices of its Norge Heat division from Detroit to Kalamazoo, Mich., to coordinate the Norge Heat activities with the Ingersoll manufacturing and engineering organization at Kalamazoo.

Five Worthington Men Promoted to Engineering Posts

Worthington Corporation has announced the promotions of five of its engineers.

John E. Lancaster, who joined the company in 1940 as a test assistant in the experimental test department, has been appointed assistant chief engineer of the air conditioning and refrigeration engineering division.

William C. Osborne, who has served for several years as a research engineer and design engineer in Worthington's centrifugal engineering department, has been named as manager of the research and development department. Assisting Osborne in the research and development department is Normal L. Meyerson, since 1943 a member of Worthington's research and development department.

Named as research engineer is Frederick C. Gilman, who joined the company in 1937. Rounding out the promotions was the appointment of T. A. Herman as assistant chief engineer of the reciprocating engineering division. Herman joined Worthington as a test engineer in 1937.

Graver Water Conditioning Company Expanding Facilities

The main office of Graver Water Conditioning Company, which was removed from Chicago to New York three years ago, has doubled its space at 216 West 14th Street. All departments, including research and product development, field service, and subdivisions of the engineering department, have been created to extend the company's facilities.

Wolverine Tube Announces Six Promotions and Transfers in Sales

The establishment of a new sales district and a series of other promotions and transfers have been announced by the Wolverine Tube Division. The new sales district covers an East-central area with Jack H. Smith, formerly the company's sales representative in Dayton, Ohio, as the district sales manager. District sales offices will be maintained in Dayton.

Kingerley

Smith

A. S. Kingerley, for many years a sales representative in the Detroit area, was appointed to the position of manager of wholesaler sales. S. C. Seekell, the company's sales representative in Grand Rapids, Mich., for several years, returns to that area, replacing James A. Jolly, transferred to the Dayton area.

Moore

Doing Pipe Fabrication Work?

...then here's an item to include on next year's budget

VERNON "Pipe-Cutting" PANTOGRAPH

Typical samples of pipe cuts

It's a big time and money saver! The PANTOGRAPH produces straight or beveled cut-offs, tee intersections, lateral intersections and miters. Handles pipe up to 24" diameter in any length. Eliminates the need for many expensive welding fittings, since intersections are cut to exact length on the pipe. All cuts are smoothly finished and beveled . . . no need for grinding, cleaning or hand fitting. The PANTOGRAPH is simple to operate . . . saves labor and material.

Write for Bulletin No. P-2

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Chemical Refining of Petroleum

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Research and Development Laboratories, Socony-Vacuum Corpn. Author of "Modern Methods of Refining Lubricating Oils"
and BERT ALLEN STAGNER, Ph.D.
Consulting and Research Chemist; Member, American Institute of Chemical Engineers; Formerly: Supervisor Chemical Research, Union Oil Company of California; Research Fellow, Mellon Institute of Industrial Research

American Chemical Society Monograph, No. 63
Second Edition, Revised and Enlarged

The rapid development of petroleum technology has necessitated a revision of the original volume published in 1933. The newest practice in regard to treatment with sulfuric acid, tetraethyl lead, octane rating, etc., is described in detail. The present emphasis on all phases of this vitally important subject makes this book a particularly timely one, especially since the petroleum problem today is rather one of refining capacity than of crude production. For this reason technical improvements are of the utmost importance for the pressing problems of national defense.

CHAPTERS

Prefaces
Composition of Petroleum
Treatment with Sulfuric Acid
Sulfuric Acid Sludge and Hydrogen Sulfide: Recovery and Manufacture of Sulfuric Acid
Treatment with Alkaline Reagents
Sweetening Operations. Elimination of Elemental Sulfur, and Reduction of Total Sulfur in Light Distillates
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Supplementary List of United States Patents on Petroleum Refining
Appendix. Special Tables
Patent. Author. Subject Indices

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OIL PROGRESS WEEK OCT. 12-18

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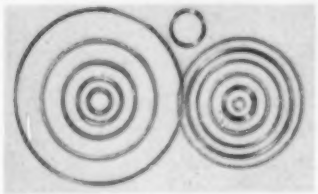

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See Page 254 in Refinery Catalog

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HOUSTON TEXAS

Richard B. Flynn, Detroit plant sales manager prior to his transfer, replaces Kingerley as sales representative in the Detroit area.

Fred F. Moore, Jr., sales representative in the Eastern district with offices in New York, has been made assistant district sales manager for the Eastern district.

Meter Specialist Appointed To Sales Position at Rockwell

Dixon

L. A. Dixon, Jr. has been appointed as vice president of the meter and gas division of Rockwell Manufacturing Company. He will coordinate the sale and manufacture of gas, water and oil meters, gas pressure regulators and Nordstrom valves.

Dixon has a long relationship with the meter industry, having devoted his full time to it after graduating from Pennsylvania State College. He started in the engineering department of the Pittsburgh-Dubois Company and in 1944 was made executive vice president. When Rockwell acquired that company in 1947 he became general manager.

Shlemmer Joins Pacific Valves; Will Have Offices in New York

Shlemmer

Pacific Valves, Inc., recently announced that Frank Shlemmer has joined the company as the Eastern Coast Divisional sales manager. His headquarters will be located in New York City.

Shlemmer will be remembered in Los Angeles as purchasing agent for The Texas Company. He served in that capacity for a number of years.

For the past four years he has been purchasing agent for The Texas Company in New York City.

[Company Changes]

Alden R. Loosli has been named assistant to the general manager at the calco chemical division, American Cyanamid Company . . . **Alfred J. Munday**, Chicago branch manager of Kinney Manufacturing Company for 35 years, has retired . . . American Cyanamid Company, calco chemical division, has appointed **Dr. V. E. Wellman** who joined the company in 1945, as assistant manager of the intermediate and rubber chemicals department . . . At a recent meeting of the board of directors of Newark Wire Cloth Company, the following appointment of officers was confirmed: **Leggett C. Campbell**, president and general manager; **John L. Campbell**, executive vice president; **E. Campbell**, vice president; **Roger W. Campbell**, secretary; and **David W. Campbell**, treasurer . . . **Robert D. Walker**, a member of Nomads, was recently appointed to The Weatherhead Company staff of industrial sales engineers and will handle sales of Weatherhead Ermeto tube fittings in the Southwest . . . **Ames B. Hettrick** has been appointed as manager of the newly-formed calco engineering and development department of the calco chemical division, American Cyanamid Company . . . Gustin-Bacon Manufacturing Company recently announced the appointment of **Edward A. McCabe**, who has been with the company since 1942 as manager of its New York division . . . **Walter L. Price**, vice president in charge of accounting and freight claims for the Baltimore and Ohio Railroad, has been elected a director of The Davison Chemical Corporation to fill the vacancy

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For purge systems, liquid level and specific gravity measurements.

Maintains constant purge rate regardless of down stream pressure changes
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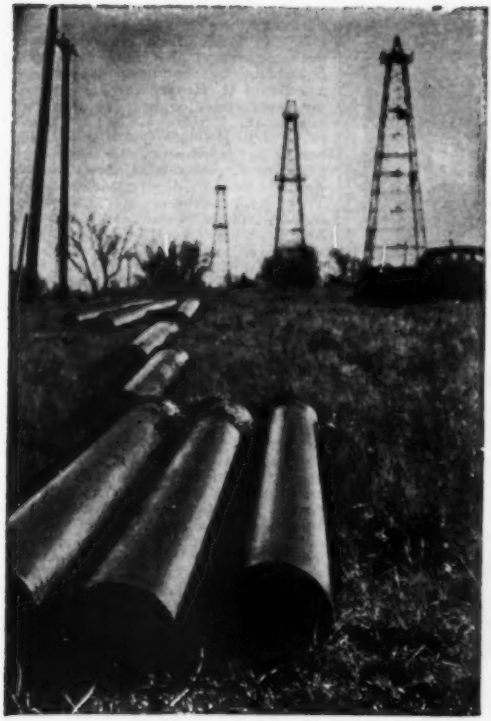

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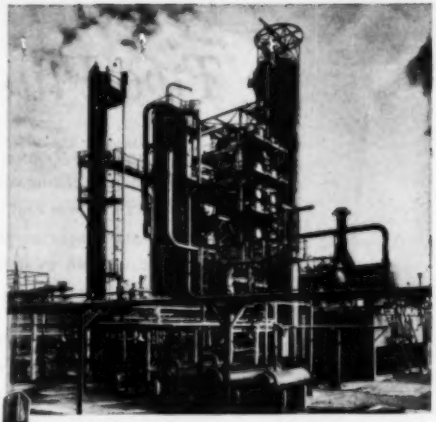

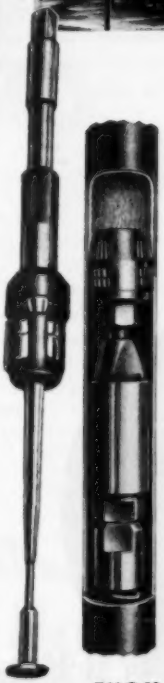

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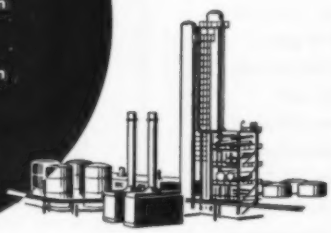

BADGER MANUFACTURING COMPANY

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caused by the resignation of R. L. Snodgrass . . . **Robert Kirk**, export manager for the chemical division of McKesson & Robbins, Inc., for the past six years, and **David H. Hoyer**, who has directed the export sales of agricultural chemicals for the Pittsburgh Coke & Chemical Company since 1948, have been named to key positions in Pittsburgh Coke & Chemical Company's newly-formed foreign department in New York. Kirk will serve as manager of the department, which will direct the company's overseas chemical operations, and Hoyer will fill the position of sales manager . . . **William J. Thomas**, general sales manager of the Tubular Products Division of The Babcock and Wilcox Company, has been named to the board of directors of the division . . . **T. A. Sullivan**, supervisor of order service in the process equipment division, A. O. Smith Corporation, has been named product manager for the pressure vessels in the division. Also at the A. O. Smith Corporation, **R. T. Springate**, factory manager of the truck frame division, has become superintendent of production control in the process equipment division. Springate will be succeeded in his truck frame post by **T. E. Dillion**. . . The Davison Chemical Corporation has announced the appointment of **Burton W. Graham**, formerly assistant general sales manager, industrial chemical department, as director of the corporation's technical services.

Chiksan Assigns Weco to Handle Sales in Rocky Mountain Area

The Well Equipment Manufacturing Corporation division of Chiksan Company has taken over the distribution and sale of Chiksan and Weco products in the Rocky Mountain and Williston Basin areas. All orders for Chiksan and Weco materials in these areas will be directed to the Weco division.

Offices are being established for the Well Equipment Manufacturing Corporation in Casper, Wyo. and in Denver, Colo.

Harris Pump & Supply Named Kinney Sales Representatives

Kinney Manufacturing Company, Boston, Mass., subsidiary of The New York Air Brake Company, manufacturers of high vacuum pumps and rotary liquid pumps, have announced the appointment of Harris Pump & Supply Company, Pittsburgh, Pa., as their sales representatives in western Pennsylvania and West Virginia.

Service Engineering Signed As Worthington Distributor

A distributorship agreement has recently been signed by Service Engineering Company, Inc., Tulsa, Okla., with Worthington Corporation by which the Tulsa firm will handle Worthington's Multi-V-Drives and Allspeed Selectors.

U. S. Steel Names Shaughness To Head West Texas District

The appointment of Tom B. Shaughness as assistant manager, Central Midwest Area, in charge of the West Texas district, whose headquarters are at Midland, Texas, has been announced. He has served as area engineer for the Gulf Coast Area since early 1946. He joined "Oilwell" in 1934 following his graduation from the Stevens Institute of Technology with a degree in mechanical

engineering. In 1945, he was appointed district engineer at Harvey, La., which position he held until he became area engineer at Houston.

General Electric Decentralizes Fractional HP Motor Department

A decentralization of the General Electric Company's Fractional Horsepower Motor Department into four separate sub-departments, each with a general manager, has been announced. The new sub-departments and general managers are: General AC Motor Sub-Department, Lisle D. Hodell; Hermetic Motor Sub-Department, Ab Martin; Specialty Motor Sub-Department, Jack J. Clarkson; and Electric Sink and Laundry Motor Sub-Department, Carl W. Moeller.

The reorganization is part of a company-wide decentralization program.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF PETROLEUM REFINER, published monthly at Houston, Texas, for October, 1952.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Ray L. Dudley, 3371 Chevy Chase, Houston, Texas; Editor, Dr. John J. Mcketta, Jr., 3912 Gramercy, Houston, Texas; Managing Editor, Silas B. Ragsdale, 1636 North Boulevard, Houston, Texas; Business Manager, A. L. Burns, No. 7 Chelsea Place, Houston, Texas.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.)

The Gulf Publishing Company, Houston, Texas; James Anderson, Houston, Texas; June Wooden Bliss, Houston, Texas; June Wooden Dudley Bliss—Trustee, Houston, Texas; A. L. Burns, Houston, Texas; Mrs. Grace C. Carter, Tulsa, Oklahoma; Mrs. Margaret D. Cashman, Houston, Texas; P. Stinson Dudley, Gainesville, Texas; Ray L. Dudley, Houston, Texas; Wm. G. Dudley, Lake Jackson, Texas; Wm. V. Gross, Utopia, Texas; Carolyn Dodson Keeble, Pecos, Texas; Mrs. Audra S. Lane, Houston, Texas; Charles H. Lane, Houston, Texas; James William Nelson, Baytown, Texas; Tom W. Nelson, Houston, Texas; J. Kent Ridley (Deceased), Houston, Texas; Walter Gage Sterling, Trustee, Houston, Texas; O. R. Waller, Chicago, Illinois; Mrs. Patricia McFarland Windham, Austin, Texas.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) M. D. Anderson Foundation, Houston, Texas.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)

A. L. BURNS, Business Manager.

Sworn to and subscribed before me this 8th day of September, 1952

P. J. AUCOIN,

(Seal) Notary Public in and for Harris County, Texas.
(My commission expires June 1, 1953.)

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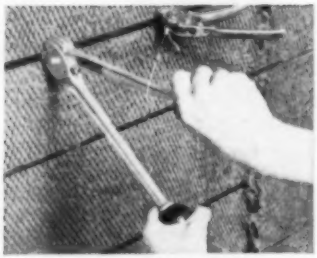

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All classified ads payable in advance. Ten percent discount for two or more insertions of same copy in consecutive issues. COPY DEADLINE: 25th of month preceding date of issue; Send copy and remittance to: Classified Ad Department, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

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Vacuum distillation Unit for distilling topped crude and obtain luboils distillates and bitumen residue, of an approximate capacity of 100 barrels feed stock (topped crude) per 24 hours including: pipe heater, fractionating tower, coolers, heat exchangers, pumps, vacuum equipment, control instruments, steel construction, steam superheater, etc. All in good condition to be delivered FOB or FAS Atlantic Port of U.S.A. Write to: "ELBYN" LUBRICATING OIL REFINERY LTD., MOSHATAN—ATHENS, GREECE.

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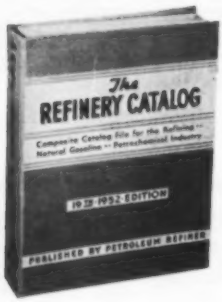
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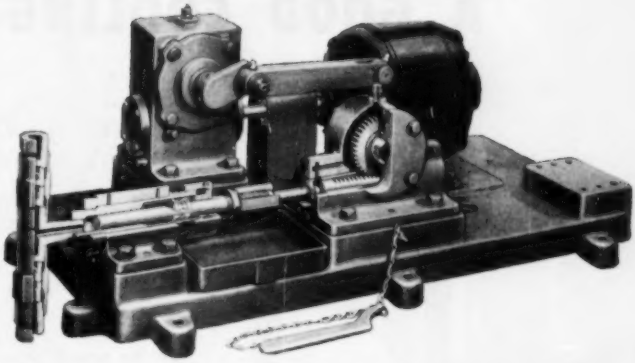

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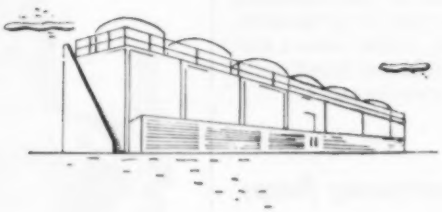

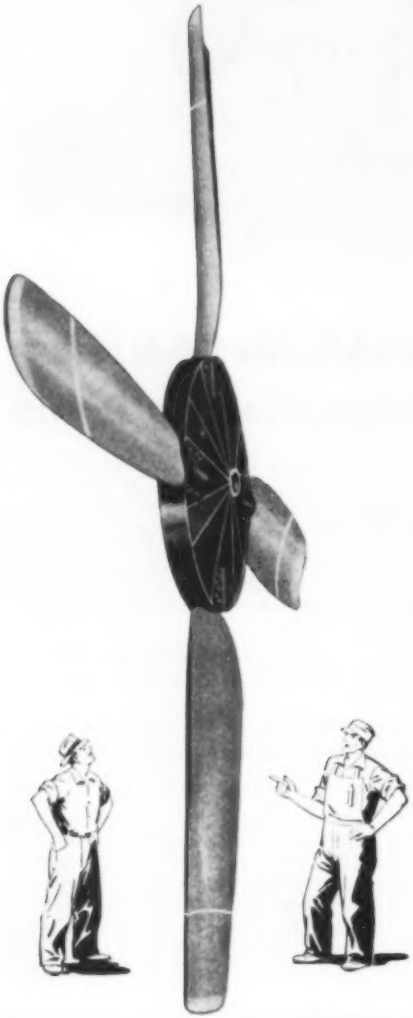

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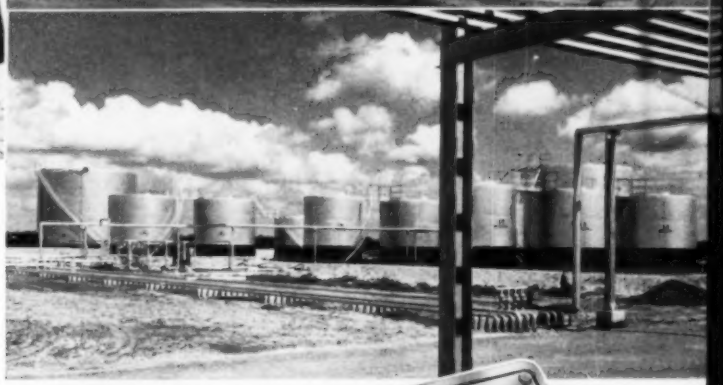

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Plate 983 — Single Master Swing Joint. Sizes 1½ to 3 inches.

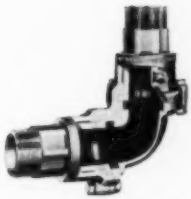


Plate 984 — Double Master Swing Joint. Sizes: 1½ to 3 inches.

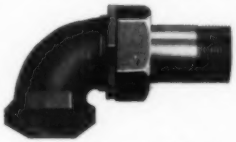


Plate 823 — Special All-Bronze Single Swing Joint. Sizes: ¾ to 1¼ inches.

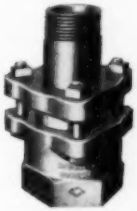
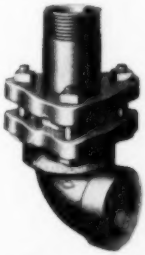


Plate 889 — Straight Standard Swing Joint. Sizes 1¼ to 4 inches.

Plate 814 Double Standard Swing Joint.



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